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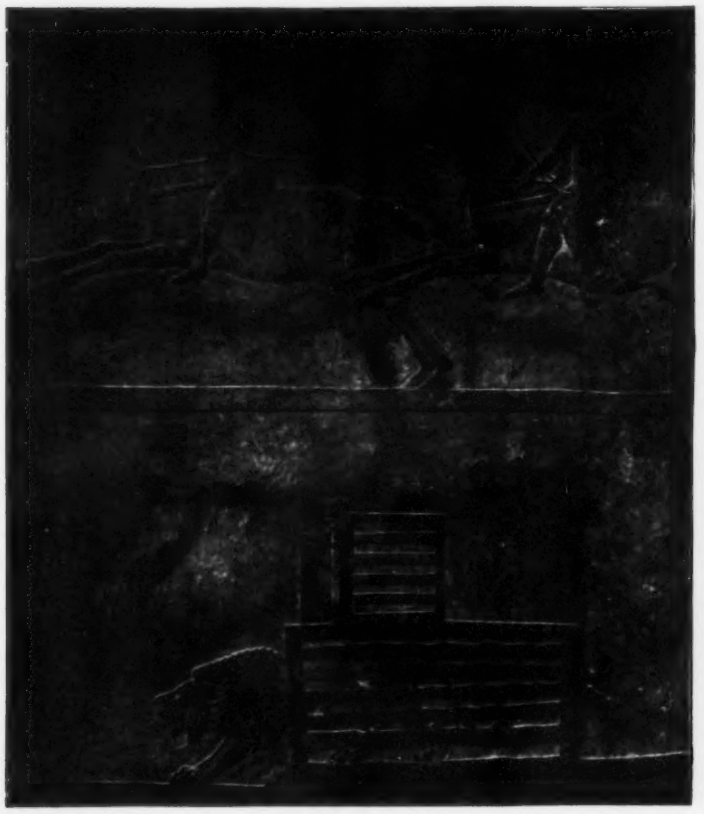
ASSURNAZIRPAL, KING OF ASSYRIA 884–860 B. C.

ASSYRIAN ASSAULT OF A CITY (CAMPAIGN OF SENNACHERIB, KING OF ASSYRIA 705–681 B. C.)

ASSYRIAN CHERUBIC FIGURE—WINGED HUMAN-HEADED LION.



CAPTIVE LIONS RELEASED FROM CAGE FOR THE ROYAL SPORT.

DISCOVERIES IN MESOPOTAMIA.

DISCOVERIES IN MESOPOTAMIA.*

By Dr. FREIDRICH DELITZSCH.

THE traveler starting overland from the port of Alexandretta, in northern Syria, beholds beyond the high pass of Beilan the widely extended plain of Antioch, a view surprising in novelty and charm. As far as the eye can reach the plain is strewn with mounds of varying height, often grass covered, their artificial origin easily discernible. These mysterious elevations, called by the Arabs "Tell," by the Turks "Tepe," accompany the traveler to Aleppo and even farther to the banks of the Euphrates and Tigris, and they constantly increase in height, extent, and number, from Mosul down the stream and through Babylonia, crossing into the Elamite plain and to Susa. They are the marks of the civilization of pre-Christian milleniums. The large and small cities of the oldest empires of western Asia, of the Hittite States of northern Syria, of the Assyrian, Babylonian, and Elamite empires, with their palaces and temples, walls and gates, terraces and towers, lie buried beneath them. From these mounds of ruins of the Euphrates and Tigris region, weather beaten, grave, and silent, rising from the lonely and lifeless desert, French, English, and American explorers have plucked unfading laurels. They have awakened to new life, after the sleep of thousands of years, the buried glory of millenniums gone, and from innumerable monuments of sculpture and writing living knowledge reaches us of Babylon, Nineveh, and of those earlier peoples whose civilization continues, in not a small measure, to be preserved in our own. The mounds of ruins in the fairyland of "The Thousand and One Nights" have become for France, England, and America mounds of treasure-trove, from whose darkness they bring to light treasures of human art and science that are the greatest ornament and pride and the never-resting ambition of the great national museums.

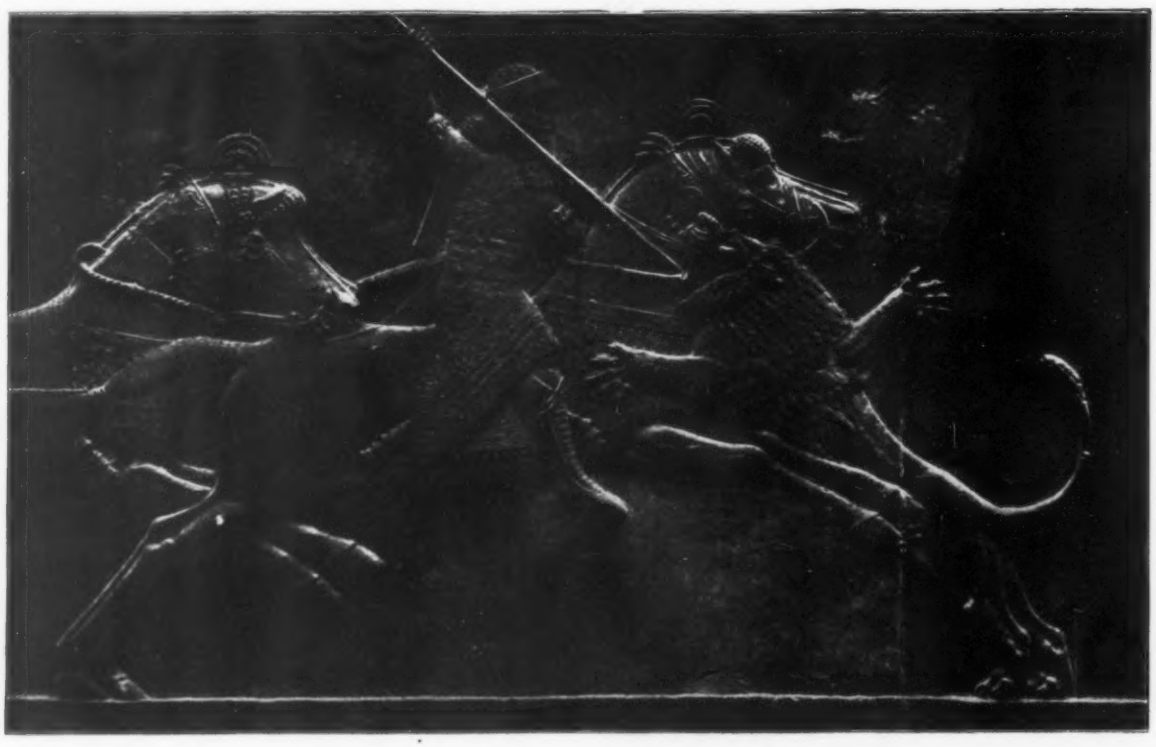
It was in the year 1820 that Claudius James Rich, an officer of the English East India Company at Bagdad, undertook, for the recovery of his health, a trip into the Kurdish Mountains, and on his way back he spent a few days at Mosul, the well-known commercial town on the right bank of the Tigris. There the large mounds on the other side of the river attracted his attention. They resembled those which he had seen near Hilla on the Euphrates and which he correctly took for the remains of ancient Babylon. As the southern of the two largest mounds still has the official name of Nunia, and is crowned with a mosque dedicated to the prophet Jonah, the hypothesis suggested itself that there, opposite Mosul, lay the ruins of Nineveh, the ancient capital of Assyria. Rich examined the mounds. He also heard of a large stone slab, engraved with representations of human figures and animals, which had been found some time before, but had been broken by the Turks because of religious prejudice. He was not, however, in a position to continue his investigations.

Now it happened that in 1842 Emil Botta, son of the well-known Italian historian, was appointed French consul at Mosul, and was encouraged by the famous orientalist, Julius von Mohl—the second of the four brothers Mohl, who are a lasting honor to their native city, Stuttgart—to follow up the path entered upon by Rich and to begin excavations in the mounds near Mosul. But neither on the southern mound, Nebi Yunus, nor on the northern, Kuyunjik, were his endeavors rewarded with success. In March, 1842, a peasant of Khorsabad, a village situated four hours north of Mosul, told him that in the mound on which his village was built inscribed stones and similar objects had been found in great number. Botta thereupon began, on the 20th of March, to dig in Khorsabad, and after but three days a room was opened, and a few days later another, the inner walls covered with alabaster slabs, on which were represented in bas-relief the campaigns and hunts, the gods and priests of a king. Full of joy, Botta, on the 2d of May, sent to Mohl a letter, with drawings of the inscriptions and sculptures. The drawings caused a lively sensation, and the French government immediately made an appropriation for further excavations. Botta had discovered, as we now know, the palace of Sargon, the conqueror of Samaria. In May, 1844, the inhabitants of the village were removed, with the permission of the Sublime Porte, and thereupon the excavations continued on a larger scale. New rooms were continually freed from the débris, new sculptures, still exhibiting traces of color, together with long-lined inscriptions, were continually brought to light, and the drawings of the French painter, Eugène Flandin, which were later published at the cost of the State, served to raise still higher the general interest in Assyrian art and civilization, which was believed irrevocably lost, and now, as if by magic, raised to new life. Botta's successor, Victor Place, found, in 1852, the walls and gates of the city of Sargon, with gigantic winged bulls, and completed the excavation of the palace, penetrating to the cellar, where the wine jars, with a reddish sediment in the bottom, were still standing in long rows. An Assyrian king, concerning whom until then only a simple brief notice in the Old Testament (Isaiah XX., 1) gave information, suddenly rose before our eyes as a live, tangible personage, and we now know as much about his wars and victories, his buildings and hunts, about the conditions of the civilization of the Assyrian Empire and the contemporaneous history of the neighboring states, as we know about any epoch of ancient Greece or Rome.

It may be readily imagined that the glorious achievements accomplished by French pluck, energy, and perseverance, which turned the eyes of the whole civilized world to the Assyrian collections in the Louvre, would not long leave the English idle spectators. Sir Austen Henry Layard, afterward minister of Great Britain in Madrid and ambassador to Constantinople, had already visited those regions in 1840, and had shown the most lively interest in the work of Botta. It was not long before the English ambassador at Constantinople, Sir Stratford Canning, succeeded in securing for Layard the firman permitting excavations and the necessary funds. Layard immediately began excavations on a grand scale, receiving the cordial aid of the native population, for not only was Layard an adept in winning the love and gratitude of the natives everywhere, but he had also in Hormuzd Rassam the most ideal companion, who, fully familiar with the Arabic character, could, as Layard acknowledged, secure the good will of the most savage with whom he came in contact.

On November 28, 1845, Layard commenced his labors in Nimrud, situated a few kilometers south of Nineveh, and the first four months of 1846 brought to light the entire northwest palace of Shalmaneser I. (1300 B. C.), the palace of Assurnazirpal, of the Biblical Tiglathpileser and Esarhaddon, and, especially with the palace of Assurnazirpal, a large number of sculptures and inscriptions of various kinds. Not less successful were the excavations at Nineveh, which Layard carried on after 1849 at the expense of the British Museum. Like the Babylonians, their masters, the Assyrian kings built their temples and palaces upon raised artificial terraces, from whose airy heights they not only enjoyed a purer and cooler atmosphere, but escaped the fever, the inundations, and the mosquito swarms of the river flats. King Sennacherib erected such an elevated terrace of bricks, and his grandson, Assurbanipal, the Greek Sardanapalus, extended it. Both of these rulers built there magnificent palaces, surrounded by large parks, rivulets, and ponds, on whose isles water birds nested. And all this splendor and glory, covered by the mighty mound of ruins of Kuyunjik, were uncovered by the two English explorers. In the southwest corner of the mound Layard laid open the palace of Sennacherib, the largest Assyrian palace thus far known, with seventy-one rooms, galleries, and halls, the walls on every side covered with artistic bas-relief, depicting the edifices, the campaigns, and the domestic life of the king in a most vivid manner. There we see how the large terrace was filled up, how the gigantic bulls that guard the entrance to the hall were set in place by means of pulleys, rollers, and ropes, and a contingent of thousands of workmen, partly slaves in chains, whom the king superintended from his chariot, while pitiless taskmasters with raised sticks relentlessly urged on the work. In another room the sculptures show servants carrying bunches of ripe dates and flat wicker baskets with pomegranates, apples, and grapes, grasping at the same time small green twigs to keep off the flies. They are followed by others with hares, partridges, and dried locusts fastened on staves. Farther on come servants, two abreast, carrying on their shoulders low tables loaded with baskets of cakes and fruits, while in the rear follow a long line of servants with flower-decorated vases. All these representations are distinguished by vividness and truthfulness.

Splendid and admirable as were the finds in the so-called southwest palace of Sennacherib, they were to be greatly surpassed by the treasures which were brought to light from the so-called north palace of Sardanapalus, discovered by Rassam in 1854. There, too, one state chamber after another was freed from débris; the long Babylonian gallery, the smaller Arabic room, so named because their wall reliefs represent the great deeds of the king and his armies in Babylonia, Arabia, etc. After two and a half thousand years of darkness the light of the sun again burst in the halls decorated with sculptures and in the courts artistically plastered with mosaics, exactly as when they were deserted in the year 607 B. C., when the Median hordes, intoxicated with the blood of foes and the triumph of victory, raged there, burning and plundering. Light fell anew into the royal harem, conjuring up before our eyes most vividly scenes with which an artist of the seventh pre-Christian century decorated its walls with realistic truthfulness. We behold in an arbor the king comfortably stretched upon a divan holding a full goblet in his hand, and near him, likewise with a goblet, the queen on a high chair, attired in rich vestments. Eunuchs fan the royal couple, while at a distance there is music. Not far from these apartments the beautiful lions' room was found, its sculptured walls perpetuating the king's adventures in the chase. Like most of the Assyrian kings Sardanapalus was a bold, passionate hunter, and the lions' chase was his favorite sport. The lions were confined in cages in a special park and on the day of the hunt were set free. Here we see the king, now on foot, now in the chariot, taking up the battle with the lion. Now the king calmly meets the attacking animal, and, with a sure hand, thrusts the deadly spear into his body. There the furious beasts fasten their teeth in the chariot spokes or writhe wounded upon the ground. Especially to be noted is a relief of a dying lioness, whose perfectly realistic character has made it famous in the history of art. On the floor of the lion apartment and of the adjoining rooms lay in thick layers fragments of the royal library, a collection of tablet books and documents once arranged in the upper rooms, but which at the collapse fell through, crushed into thousands of large and small pieces. Baked clay tablets of all sizes, inscribed on both sides with fine Assyrian cuneiform characters, which, after being freed from



ASSURBANIPAL, KING OF ASSYRIA 668–626 B. C., LION HUNTING.

DISCOVERIES IN MESOPOTAMIA.

* Translation of Ex Oriente Lux. Ein Wort zur Förderung der Deutschen Orient-Gesellschaft von Dr. Friedrich Delitzsch, ord. Professor an der Universität zu Breslau. Leipzig: F. C. Hinrichs'sche Buchhandlung, 1666. Pp. 16, 8vo. Dr. Delitzsch has also contributed the other articles in this series of publications.—From the Annual Report of Smithsonian Institution for 1900.

dirt and dust can be as distinctly read as if they were but yesterday impressed into the soft clay, constituted this unique royal library.

As if presaging the approaching collapse of the Assyrian Empire, Sardanapalus ordered that the most important books and documents from all the libraries in Babylonia should be collected, copied, some even in duplicate, and incorporated in his own library. Thus through the library of Sardanapalus there came to us a great part of the older, and indeed of the most ancient, works of Babylonian literature, and, as might be expected, only the most important works were considered worthy of admission into the royal library. It contained historical works with information as to the relations, now peaceful, more often warlike, of Assyria with its mother country, Babylonia; chronological lists accurately fixing the reigns of all those ancient kings, Shalmaneser, Tiglathpileser, Sardanapalus, and for a long period recording the most important event of each year; penitential psalms and hymns of praise, epics, and myths that reveal the religious thought as well as the poetical endowment of the Babylonian people; large grammatico-lexicographical works that for many decades to come will be an inexhaustible mine for Semitic philology; astronomical, astrological, and magical tablets, the original works from which the wise men of the East—the Babylonian Magi—drew their learning which they afterward spread over Greece and Rome; in addition a multitude of letters addressed to the great king of Assyria from the kings of Elam, from the generals abroad in hostile lands, from the court astronomers who report to the king the happenings in the starry heavens, eclipses of the sun and moon, from the Magi, who, on the basis of the flight of birds, or the entrails of sacrificial animals, advise the royal majesty what to do and what to leave undone; letters from the royal physicians, petitions and entreaties from captives; besides copies of the letters and proclamations of the king himself. Four royal-octavo volumes, with 1,952 pages, are required for the catalogue of the thousands of clay tablets and prisms or fragments thus far transferred from Nineveh to the British Museum. And what a mass of knowledge and multitude of new points of view for religious and profane history, for linguistics and geography, for archæology in all its branches, has not the study of these ancient books revealed! Let us but recall that memorable autumn of 1872, when George Smith, one of the officers of the Egypto-Assyrian collection of the British Museum, while looking over the cuneiform fragments of the mythological series, read in one of them with growing surprise: "The ship stood still on the Mount Nizir. I took out a dove and sent it out; the dove flew hither and thither, but as it found no resting place it turned and came back. I took out a swallow and sent it out. The swallow flew hither and thither, but as there was no resting place it came back. I took out a raven and sent it out; the raven flew away and perceived the decrease of the water . . . and did not return to the ship." Smith had found the original of the Babylonian-Biblical account of the deluge. He reported his find at the meeting of the London Society for Biblical Archæology on December 3, 1872. The discovery created the profoundest sensation in England, and far beyond her borders. In press and pulpit it was celebrated and commented upon. Babel, it was said, confirms the Bible. "Where men are silent, the stones cry out." The proprietors of The Daily Telegraph, almost immediately after that lecture, hastened to give George Smith a thousand guineas for further explorations in Nineveh. On January 20, 1873, George Smith set out on his journey. In 1874 he was again sent—this time by the trustees of the British Museum—to Nineveh, constantly making discoveries, and in 1876 undertook a third expedition to the East, which was to be for him "a way without return." His last stay in Babylonia and Assyria—full of exertions and trials, where, at the time, pest and cholera were raging—exhausted the strength of the indefatigable explorer. Accompanied by the English consul to Aleppo, he died there on August 19, 1876, covered with glory, fallen like a hero on the field of honor.

The traveler setting out from Bagdad in the direction of the little town of Hilla, traversing the plain which is spread out between the twin rivers Euphrates and Tigris where they are nearest one another, will, after passing many other mounds of ruins, arrive at a large one covering two English miles, named Abu Habba. Wall and castle are still clearly recognizable, but the highest point of this site of ruins is on the southwest side on the bank of a former arm of the Euphrates. When Rassam excavated here in 1881 he struck almost at once the walls of a building. The inclosure of a large quadrangular structure 1,500 feet long on the southwest side, was laid bare, and further trenches and shafts showed that the edifices were grouped around a central court, and consisted of a line of long narrow rooms with exceptionally thick brick walls. In the interior of this structure a pair of interesting rooms was discovered and freed from the débris. At the excavating of a shaft that ran along a wall in the middle of the mound a doorway was reached which led to a large gallery 100 feet long and about 35 feet wide. On it stood the remnants of a large sacrificial altar, made of bricks and measuring 30 feet square. Behind the altar, in the wall of this room, a door opened leading to a smaller room, and Rassam, as a result of experience gained in the Assyrian mound of Balawat, at once surmised that the temple archives had been here preserved. But though at Balawat the corner-stone documents of the builder of the temple were found in a stone chest nothing similar was here discovered. On the other hand the asphalt pavement attracted Rassam's attention and he therefore sunk a shaft in the floor when, behold, scarcely had he broken through the cement layer when a clay chest appeared containing a beautiful artistically inscribed alabaster tablet, in six columns, decorated at the top with a carefully executed bas-relief. In this holy of holies a god with a long-flowing beard, in his hand a ring and a short staff, was seated upon a throne decorated with cherubim. A king followed by two priests approaches the god in adoration, while two other men are raising the sun disk with ropes upon the roof of the holy of holies. Certainly a valuable and admirable find in itself but much more so because this document also revealed the name of the building and of the city which was thus rediscovered. "Image of the sun god, the great lord, who dwells in the temple Ebabbara in the city of Sippar." Thus reads the explanatory legend of the bas-relief. One of the oldest Babylonian cities has been found—Sippar, in which Noah-Xisuthros, by the command of the god Kronos, was ordered to bury the documents of antediluvian times; the sun temple which since its foundation in the fourth millennium until long after the time of the last Chaldean king, Nabonaid (538 B. C.), was the center of worship for Babylonia and the object of concern of all Babylonian kings was rediscovered. This sun temple in the course of thousands of years through revenues and donations came in possession of untold riches in money and land.

The forty to fifty thousand inscribed tablets that since 1881 have been flowing from Abu Habba as from an inexhaustible source into the occidental museums, above all into the British Museum, give an insight not only into the cult of the sun god and the deities worshiped beside him, into the divisions, obligations, and prerogatives of the several priest classes, but also into the system of the temple revenues and their application. From the temple archives of the sun god is derived a great mass of tablets, which, after the fashion of commercial bookkeeping, record the temple revenues in money and other commodities, the expenses in salaries, wages, etc., and the investment and employment of the temple property in loans, real estate, rents, etc. If to these be added the numerous so-called contract tablets from Babylonia, Tell Sifr, and other places, with their varied contents, purchase and sale of slaves, marriage documents, acts of lawsuits, testaments, and the letters of the time of Hammurabi or Amraphel (Genesis, XIV.) which were recently found, we derive a mass of the most important information on the commercial and judicial life as well as the economic conditions in the Babylonian State for a period of nearly two thousand years from the first Babylonian dynasty (2250 B. C.) until long after the time of the Achæmenian kings. The excavations at Sippar, Babylon, and elsewhere carried us back to the time of Hammurabi, that greatest king of the first Babylonian dynasty, who united the north and the south in one great Babylonian State, with Babylon as the capital. But the soil of Babylonia, inexhaustible in surprises, was soon to afford us an outlook into a much higher antiquity of the Babylonian people and to carry us to still more remote ages in the history of humanity. From the same archives to which the above-mentioned votive tablet belonged, which was deposited by King Nebobaladan (882 B. C.) in the sun temple at Sippar, came also, among other things, a remarkable clay cylinder of the last Chaldean king, Nabonaid. In it the king relates that he has decided to re-establish the sun temple upon its oldest foundation; for, in consequence of the repeated rebuildings in the course of many centuries, the temple was obviously detached from its original foundation site, from its oldest "temen;" and that he has succeeded, after continuous and laborious digging into the depths of the earth, in finding the "temen" of the first builder of the temple Naram-Sin, son of Sargon I., a "temen" which for thirty-two hundred years had not been seen by the eye of man. This established the year 3750 before our era as the date of the reign of Naram-Sin and about 3800 as that of Sargon I., and opened a vista into the past of the human race on Babylonian soil which lies fifteen hundred years beyond the time of Hammurabi-Amraphel, or, to speak with the Old Testament, beyond the time of Abraham, a vista never anticipated and at first hardly credible. And still, little as was the inclination to accept so remote a date, there was as little reason to doubt it, and, in fact, the progress of the excavations was soon to prove it more and more indubitable.

ASSURBANIPAL POURING A LIBATION OVER LIONS SLAIN IN THE CHASE.

DISCOVERIES IN MESOPOTAMIA.

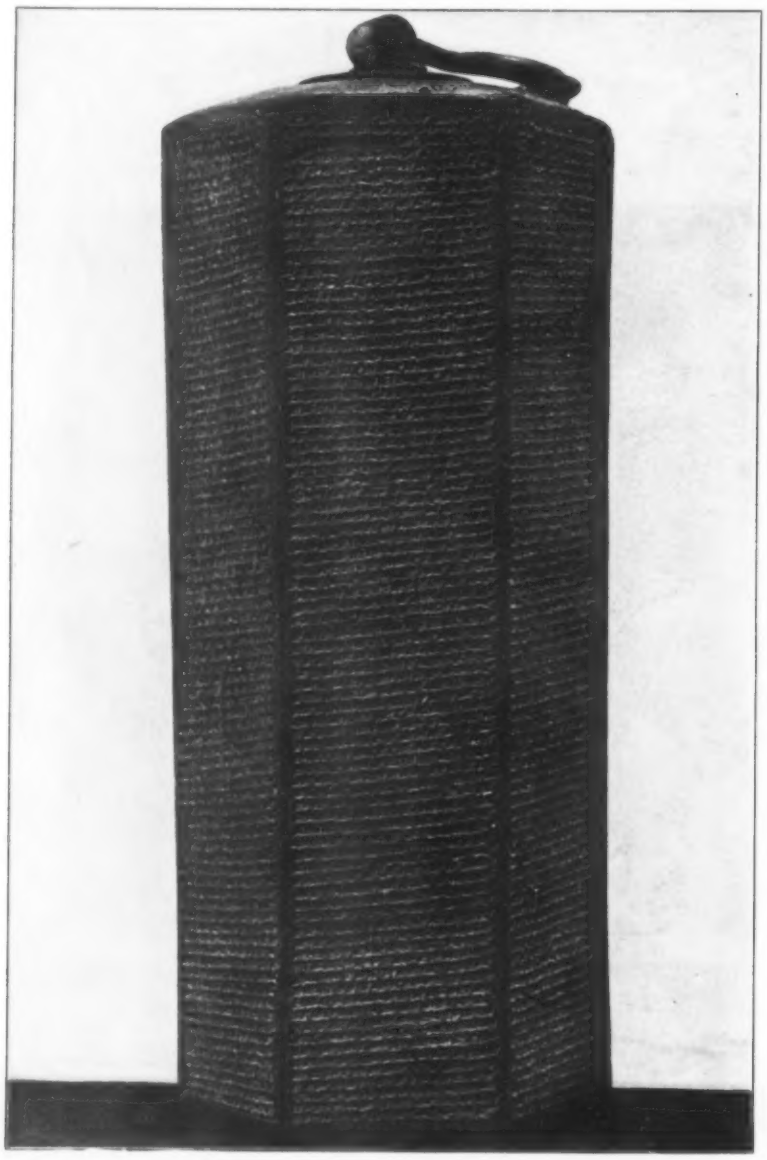
The French consul at Bassora, Ernest de Sarzec, who has been directing the French excavations on the south Babylonian site of the ruins of Tell Loh (Telloh) since 1875, had not long begun his work when he found those nine diorite statues, which represented partly in standing position, partly seated, the old priest kings (patesi) of the city of Lagash, named Ur-Bau and Gudea. These statues, although the heads of all are missing, are valuable examples of the old Babylonian art of sculpture, and this value is considerably increased by the inscriptions which, on the breast, back, etc., are incised with the most consummate artistic skill and neatness, exciting the admiration of our modern stonecutters. While the archaism of the writing leads us back to a time long before Hammurabi, the language in which they are composed shows that those ancient priest kings belonged neither to the Semitic nor to the Indo-Germanic stratum of the Babylonian population, but to the so-called Sumerian people, who spoke an agglutinative language, and who, though through the early centuries settled in Babylonia contemporaneously with the Semites, and in lively intercourse with them, must still be considered as the older native population from whom the Semites received the art of writing and other achievements of civilization. And since that first great discovery of De Sarzec, the finds of Telloh

have steadily carried Babylonian history to earlier periods as evinced by indisputable art, historical and paleographical criteria. They carried it back to the time when the two Semitic kings of Agade, Sargani-shar-ali and Naram-Sin—and these, as is recognized with ever-increasing certainty, are Nabonaid's Sargon and Naram-Sin (3800 and 3750 B. C., respectively)—exercised sovereignty over Lagash and the priest king of this city, Lagal-Ushumgal, was their vassal. Nay, even from an earlier time—the close of the fifth millennium—there rises before our eyes a whole line of hoary Sumerian patesis of Lagash—Ur-Nina, Akurgal, Eannadu, Enannatum, Entemena. And we know not only their names, but most of their heroism against domestic and foreign foes, and of their efforts for the general welfare of their city and its inhabitants.

As the origin of the cuneiform writing is more and more cleared up through the inscriptions of some of these most ancient rulers—above all, that of Eannadu—so one ray of light after another brightens the darkness spread over the earliest history of the great Babylonian cities—Agade, Babel, Kish, and Lagash, Erek, and the "city of bows." Nay, on some periods, especially the times of Sargon I. and his son, Naram-Sin, a flood of light is shed. For much as it may be deplored that the archives, consisting of some 30,000 tablets, cylinders, and large inscribed pebbles, found in 1894 in a cellar-shaped room at Telloh, were scattered everywhere by the thievish Arabs, the documents themselves are not lost to science, whether they came to the museums of Constantinople, Paris, Berlin, Philadelphia, or elsewhere; and they reveal to us in a surprising and at the same time in detailed manner the commercial, agricultural, and economic conditions, as well as the civic and religious life of the times of Sargon I. and Naram-Sin. Even pierced lumps of clay were found with the names of Sargon or Naram-Sin stamped upon them, inscribed with the names of the addressee, the place of destination, and evidently attached to bales of merchandise, to be forwarded from Agade to Lagash.

One of the oldest sanctuaries upon earth is the temple of the lord of the universe, Bel, in the middle Babylonian city of Nippur. The ruins of this city, now called Nuffar, and especially the gigantic remains of this temple, were the goal of the three expeditions from Philadelphia, which, from 1886 up to the present time, under the direction of John P. Peters, Hermann V. Hilprecht, and J. H. Haynes, have excavated and constantly made discoveries of the greatest import to science on that vast site of ruins. Two temple archives rewarded the labors of the American explorers within a few years. True, those of Sargon I. lay in ruins; enemies, probably the Elamites, plundered and destroyed them. But if only the vases of the pre-Sargonic king of Erek, Lugal Zaggisi, son of a patesi of the "city of bows," which were pieced together from thousands of fragments, had been found they would be an ample reward on account of the historical and paleographical information that they furnish. The records of the Kossean kings were intact. They contained all the votive gifts that the kings of the so-called third Babylonian dynasty had presented to the god Bel.

Down to 1896 there were cleared from the ruins of Nuffar, successively, 2,000, 8,000, and 21,000 clay tablets and fragments, inscribed and stamped bricks, stone and clay vases. They were of the pre-Sargonic period, as well as of all the later periods of Babylonian history, from Sargon I. and Naram-Sin, and even from Ur-Gur and Dungi, the two ancient kings of the city of Ur, down to Darius II. and Artaxerxes Mnemon. They embraced syllabaries, chronological lists, letters, astronomical and religious texts, tax lists, plans of real estate, contracts, besides images of divinities and toys of terra cotta, weapons and implements of stone and metal, ornaments of gold, silver, copper, and bronze, carved precious stones and weights. It was estimated that the inscribed monuments found up to 1896 would fill twelve volumes of two to three parts each if published. What specially distinguishes the excavations of the Americans is the systematic clearing up of the single layers of the mighty temple edifice and of its superstructure.



ASSYRIAN ACCOUNT OF SENNACHERIB'S CAMPAIGN AGAINST JERUSALEM AND KING HEZEKIAH OF JUDAH (701 B. C.)

DISCOVERIES IN MESOPOTAMIA.

The colossal ruin of the tower of the temple of Bel, now called Bint-el-Amir, rises 29 meters above the plain and 15 meters above the mass of débris which surrounds it. The immense platform, about 2.40 meters thick, constructed of sun-dried bricks, together with the three-story temple tower erected upon it, probably a work of King Ur-Gur, was laid bare and the ascent to the single stages in the southeast of the ruin was found. Close under this platform another pavement was discovered, consisting of two layers of baked bricks of about 50 centimeters square and 8 centimeters thick. Most of them were stamped, some with the name of Sargani-shar-ali, the others with that of Naram-Sin. Both kinds were intermingled in both brick layers, so that the identity of Sargani-shar-ali with the Sargon of Nabonaid (3800 B. C.) was made sure. Ur-Gur had, it appears, razed the buildings of his predecessors and elevated the platform of his temple tower over the pavement of Naram-Sin. J. H. Haynes, however, who since 1894 has been alone at the ruins of the temple of Bel, superintending the excavations, was not content with these chronologically important revelations, but sunk shafts in several places under Naram-Sin's platform and searched the entire earth stratum, which was about 9.25 meters deep, down to the underground water, for remains of human civilization. This great sacrifice of time, labor, and perseverance was to be rewarded in a way that could not have been anticipated. For, in one place, not far below Naram-Sin's platform, was found an altar of sun-dried bricks, the top of which was surrounded by a rim of asphalt and covered with a layer of white ashes 6.5 centimeters thick and the remains of burnt sacrificial animals; still farther below there was unearthed a large, beautifully decorated terra-cotta vase in perfect condition, an excellent example of old Babylonian ceramic art. And in another part of these underground excavations the oldest architectural arch of a drainage canal, and still farther down in the deepest layers, or, what amounts to the same, back in many centuries beyond the fifth millennium, everywhere interesting and valuable remains of human civilization came to light, fragments of vessels of copper, bronze, and clay, a mass of earthenware, so beautifully lacquered in red and black that one might consider them of Greek origin, or at least influenced by Greek art, had they not been found 8 meters deep under Naram-Sin's pavement.

We could go on a long time in this way were we to enumerate all the achievements which foreign explorers, supported by the energetic interest of their governments and aided by the liberality of their countrymen, have accomplished and are still accomplishing on the ruined sites of Assyria, Babylonia, and Elam. We could speak of Hormuzd Rassam's finding of Nebuchadnezzar's palace in the middle mound of Babylon, called Kasr; of two beautiful wells which reached down to the water level of the Euphrates, and of other traces of water balances in the extreme northern mound Babil, probably the site of the hanging gardens of Semiramis. We could describe the successful expeditions of Jules Oppert, William Bennett Loftus, Sir Henry Rawlinson, and, above all, tell of the great work of the Dieulafoys on the ruins of Susa. But we must forego this here, and will mention in passing that only recently the French government succeeded in acquiring for 5,000 francs the right from the Shah of Persia to excavate for all time in Susa and the surrounding province and to transfer half of the finds to France, while for the other half it secured the first option. The French have been active in Susa since November, 1897, under the direction of De Morgan. De Sarzec and Haynes continue their labors with undiminished and untiring zeal. Philadelphia, it is rumored, is equipping a new expedition, and Germany—is she to continue for another half century to be an idle and admiring onlooker of the glorious deeds of foreign nations? Shall she longer be content to play the part of the poet, until it is proclaimed: Too late; the world is already divided?

Germany may justly be proud that one of her sons, the Hanoverian Georg Friedrich Grotefend (born in 1775 at Münden), as a young teacher at the gymnasium of Göttingen in 1802, had the genius to decipher the cuneiform writing, and thus placed the key in the hand of science which was to unlock not only the old Persian monuments but also the great Babylonian-Assyrian cuneiform literature, and in addition to that make possible the reading of the Armenian and Elamite cuneiform script. Germany may also glory in the fact that a scholar of German blood, Julius von Mohl, gave the first impulse to the excavations in Nineveh; she can also note with satisfaction that the enthusiastic interest which is being brought to the Assyriological studies especially in America, and from which grew the Philadelphia expeditions, was awakened in the German universities. If, then, Germany would at last arouse herself and secure a share of the priceless art and written monuments of the old—nay oldest—human civilization for German museums and German science, this great national and scientific undertaking may count with certainty upon the sympathy and self-sacrificing support of all men and women who are zealous for the glory of the German name and German science. No one can deny that the excavations in the mounds of Mesopotamia have opened and are continually opening new and rich sources of highest importance for an entire series of sciences—Old Testament research, ancient history and geography, the history of art and archæology, the history of religion and comparative mythology, Semitic and general philology, comparative history of jurisprudence, the history of astronomy and mathematics, and many other sciences. We must refrain from entering into details and can only briefly refer to a few facts.

For the history of art, particularly the history of sculpture and architecture, and in a measure also of painting and some of the industries, such as stone-cutting and pottery, a peculiar and highly important link was recovered through the resurrection of Assyro-Babylonian antiquity, the more important as the history of the development of the Babylonian art can be followed up to the fifth pre-Christian millennium. The image of Naram-Sin found at Diarbekr, the famous vulture stele of Eannadu, the sculpture with the representation of Ur-Nina and his sons, will forever remain milestones in the history of the art of western Asia, and of human artistic skill in general. And as it is an established fact that "the forms of the column, and some other ornaments of Greek art which are much in use are first met in Assyrian sculptures," light from the East may also be hoped for to illumine the darkness in which the origin of the oldest Greek art is in many respects still enveloped.

The light which sprang from oriental ruined mounds has with one stroke illuminated the sphere of the ancient peoples and states of western Asia, so distant in time and space, and restored it to ancient history. The nebulous forms of Ninus, Semiramis, and the effeminate Sardanapalus have been replaced by clear-cut individualities. The old great culture States—the old Babylonian, Assyrian, and Chaldean empires, their external political history and internal development in commerce and industry, law and religion, manners and customs—enter into our horizon with steadily increasing completeness and vividness. At the same time they furnish us the most valuable information on the history of the neighboring kingdoms, from Elam to Canaan, on the ethnic movements which during

four millenniums took place in the large quadrangle of lands between the Black and Caspian seas and the borders of Egypt-Arabia. And how many chronological and geographical riddles have not been solved or at least brought nearer to solution!

Assyriological research which sprung from the ruins of Babylon and Nineveh has above all shown itself fruitful for the science of the Old Testament, and for it promises to bear still more fruit. For not only is the Assyrian language most akin to Hebrew, affording new information on questions of grammar, lexicography, and phraseology but there is scarcely a book of the Old Testament the interpretation of whose subject-matter has not been aided to some extent by the cuneiform monuments. The narratives and conceptions of the Book of Genesis of the creation of the world—the serpent as the arch enemy of the Deity and embodiment of all sin and malice, the ten patriarchs, and the catastrophe of the Deluge which destroyed primitive humanity, so well known and familiar to us from childhood—appear in a new light through the surprising parallels which the Babylonian-Assyrian clay books furnish. The Old Testament history, especially that of Israel from Chedorlaomer to Belshazzar and the Achæmenian kings interlinked with the history of Babel and Asshur, continually receives new light from the latter. The chronology of the kings of Judah and Israel is through the chronology of the Assyrian empire placed on a more secure basis than was possible before; and since in the annals of the Assyrian kings mention is made of the kings Ahab and Jehu, Pekah and Hosea, Ahaz and Hezekiah, the possibility is afforded of comparing more than one narrative of the historical and prophetical books, as, for instance, that of Sennacherib's campaign against Jerusalem, with the records of the opposing side. Hebrew antiquity is connected by hundreds of threads with that of western Asia, particularly of Babylonia and Assyria. The deeper insight which we now have into the belief and cult of the gods, especially into the nature of the sacrifices of the Babylonians, their conception of the winged angelic beings after the manner of the cherubim and seraphim, their views of life after death, their bestowing of names, the peculiarities of their psalm poetry in form and matter, their mannèrs and customs, their system of measures and weights, etc., directly serve the advancement of Old Testament theology and archæology.

The resplendence of the starry sky over the endless expanse of the Euphrates' land is something wonderful; the stars sparkle with the greatest brilliancy, and the movements of the planets, the changes of the moon, the various meteors, enchant the attention at night. The Babylonians learned to calculate the course of the stars; their observations constituted the foundations of the astronomical studies of the learned Alexandrians. And when we even to-day divide the circle into 360 degrees, the day into twelve hours of sixty minutes; when we count seven days of the week and name them after the planets; when we divide the apparent path of the sun according to the signs of the zodiac, we therein directly follow those old Chaldeans, whose great scientific accuracy, while it has left traces in some other things, has borne imperishable fruit in the science of astronomy, which originated with them. And just as the first chapters of the history of astronomy can only be written with the aid of cuneiform works or notices, we must see in the same sources the history of mathematics, geometry, metrology. Nay, in many respects our present civilization is still under the influence of the hoary Babylonian; the week and its seven days and the names of so many constellations as well as our old square measure, the cubit, and our old weight, the pound, have their homes in Babylonia. Jurisprudence has good reason for the assumption that the often striking agreements between Roman and Babylonian law will clear up the origins of Roman law, which, at least partly, are still obscure. In the exceedingly rich Babylonian-Assyrian "contract literature" an abundant as well as a valuable source was disclosed for the comparative history of jurisprudence; many other functions of state institutions receive new and instructive data of a comparative and historical nature from the results of the excavations. We have in mind, for instance, the economic development of those ancient culture states, or of the history of war in its manifold branches. Do not the bas-reliefs on the alabaster slabs and bronzes of the Assyrian palaces furnish instructive information as to the progress in the clothing and arming of the Assyrian army, the developing of the cavalry, the technique of fortification, the defense and attack by means of machines of assault and mines, on scouting and pontoon building?

A new world is opened to human knowledge and inquiry through the Babylonian-Assyrian excavations. But while we zealously collect books and documents in our libraries and archives as the obvious condition of scientific progress, we stand idly by when the oldest documents and books and art monuments of humanity, the invaluable original material for a large number of scientific departments, go abroad, so that German Assyriologists, Old Testament scholars, historians, all who occupy themselves with the archæology of western Asia, with the history of art, etc., are almost entirely dependent upon foreign publications and foreign museums.

But still another consideration peremptorily demands that a change of conditions should as soon as possible take place. We German scholars continue to praise the ever-extended welcome which we receive from the directors and assistants of the British Museum, the Louvre, the National Library at Paris. We have to acknowledge the generosity with which the foreign collections are opened to us, the museum publications presented to us as a gift. But the more often we enjoy English and French hospitality the more urgent becomes the reminder, noblesse oblige. For more than fifty years German science has been availing itself of the fruits of foreign labor and sacrifice, and has been making use of achievements possible not only through enormous expenditures of money, but also by continuous sacrifices of time and comfort, health and life, on the part of the foreign explorers. It is not a small thing to do excavating yonder in Babylonia, in a climate whose temperature reaches in the shade 39 deg. Réaumur (119 deg. F.), among wild, ignorant, and treacherous Arabs, in the vicinity of widely stretching swamps, full of deadly fever germs, attacked by day and by night by ubiquitous insects. If the explorers of other nations are constantly ready to endure such sacrifices of health, nay, even life (the cemeteries of Bagdad and Aleppo bear witness to it), to science, it is certainly high time that Germany, too, imbued with a similar lofty national and scientific enthusiasm and readiness of self-sacrifice, put her hand to the raising of those treasures which are most valued by herself. There is certainly no lack of men who are ready for any sacrifice in the srvice of the fatherland and of science. As for the money, all Germany will certainly be able to do what a few generous citizens of a single American city, Philadelphia, have accomplished, they having defrayed the expenses of three expeditions from 1888 to 1896, amounting to 280,000 marks ($70,000). The self-sacrifice of generous Germans, which from 1888 to 1891 rendered possible the successful excavations of the German Orient Committee at the mound of ruins in Sendjirli, in northern Syria, will certainly not be wanting for researches on the Babylonian-Assyrian ruined sites, which, in all human probability, will be much more successful, and will put the newly organized German Orient Society in a position to energetically carry out from now on uninterruptedly and in a constantly widening compass its efforts for the study of western Asiatic as well as Egyptian antiquity for the prosperity of German museums and German science and for the glory and honor of the German fatherland.

THE ANATOMY OF PLANTS.

THE anatomy of plants is not studied like that of animals; that is to say, by dissecting them, since their tissues are too intimately connected with each other to permit of this. It is therefore necessary to make exceedingly thin sections of them and examine these under the microscope. And even then we do not see many details of structure, since each cell is easily confused with its neighbors. In order to obtain good preparations, it is necessary to clean the sections, that is to say, to remove the internal protoplasm from each cell and allow only the membrane of cellulose to remain. To this effect, they are treated with a solution of hypochlorite of lime, in which they are allowed to remain for from five to ten minutes, and are then washed with water containing a little acetic acid. This is not all; the form of the cellular elements does not always afford information as to their true nature. In order to distinguish them perfectly, it is necessary to use coloring reagents, and so they are passed successively through a solution of iodine green, water and carmine and alum. In this way, all the membranes of cellulose are colored red, while all the ligneous portions, that is to say, the vessels and fibers, are colored green.

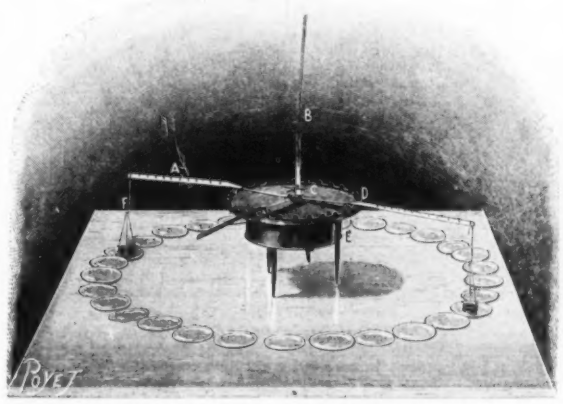
It will be seen from this that the coloring of a single section involves considerable labor. In fact, the section must be passed successively through at least ten reagents and be handled for this purpose with a flat needle. Such manipulation of the sections is so much the more difficult in proportion as they are smaller. It is necessary also to keep constant watch of the time that the sections are to remain in the reagent, and this is very fatiguing to the mind.

Such considerations have led M. Henri Coupin to devise an apparatus that permits of the operations being performed automatically. This consists essentially of a clockwork movement that causes a vertical axis to revolve in one hour. Upon this axis are fulcrumed four light levers that rest near the center upon a ring carrying alternately thirty teeth and notches. To the extremity of each lever is attached a small basket of very fine brass wire cloth, into which the sections to be colored are thrown. The reagents are arranged in a circle around the apparatus in thirty watch crystals. The following is the list: 7 (hypochlorite), 6 (dilute acetic acid), 1 (iodine green), 3 (water), 7 (carmine), 4 (water), 2 (alcohol).

The lever in revolving causes the basket that it supports to pass from one reagent to the other. The latter enters through the meshes of the wire cloth at the bottom and acts upon the section. The time of action of the reagents is proportional to the number of watch crystals that contain them. From the moment at which the sections are placed in the baskets we have therefore no longer anything to occupy ourselves with but the removal and final mounting of them. Let us remark also that it is possible to place within the circle of crystals a second circle of smaller ones and thus to color double the number of sections. Finally, it is possible to construct an apparatus with six or eight lever arms instead of four. The levers not in use may be raised vertically so as not to put too much useless strain upon the clockwork movement.

The operation of the apparatus is perfect. With it, it is easy to color forty sections in one morning, while, with the ordinary method, it is impossible to color more than five or six. This is a very sensible difference, and will certainly be regarded favorably by botanists, to whom, as well as to the common run of people, "time is money."

Let us add that after the sections have been colored as described above, it is necessary to mount them in Canada balsam in order to preserve them; but this operation can be performed only by hand. They are first dehydrated by means of absolute alcohol, which is afterward expelled by immersing the sections in xylol or oil of cloves. Finally, they are placed upon a glass slide in a drop of Canada balsam and covered with thin glass.—For the above particulars and the engraving we are indebted to La Nature.



APPARATUS FOR COLORING PLANT-SECTIONS.

A, lever arm in an operative position; *B*, lever arm in an inoperative position and raised vertically; *C*, springs to keep the levers vertical, and the axis that revolves the horizontal levers; *E*, housing for the clockwork movement; *F*, basket of wire cloth.

EXPLANATION OF THE INCLINATION OF THE PLANETARY AXES.

By WILLIAM H. PICKERING.

SUPPOSE a uniform spheroid to be revolving in its orbit about the sun and to present always the same face to a star. If this spheroid is covered with liquid an annual tide will be produced which in the process of time will cause the spheroid to rotate upon its axis so as to present always the same face to the sun, says the Astronomical Journal.

Suppose now that this spheroid possesses an original rotation about its minor axis, and that this axis lies in the plane of its orbit, as is for instance approximately the case with the planet Uranus. We shall thus have two independent rotations about two axes placed at right angles to one another. When these motions are combined, however, as may be clearly illustrated by means of the gyroscope, the effect produced is to shift the minor axis of the planet out of its original plane, so that the plane of the planet's equator shall approach the plane of its orbit, and in such a manner that the rotation and revolution shall take place in the same direction.

This shifting of the axis is not to be confused with that producing precession, which is due to a different cause and is periodic. The present shifting is continuous in its action and its direction lies at right angles to that causing precession.

According to Laplace's nebular hypothesis, as is well known, when the rings break up into planets, these should rotate in a retrograde direction. Owing to the tidal action above described, however, the plane of their rotation will gradually shift so that, from being at first nearly parallel to the plane of their orbits, it becomes later perpendicular to them, and finally again parallel, but this time with the rotation direct. Successive satellites formed by the contracting mass would thus originally revolve in different planes, but would all finally approach the plane of rotation of their primary through the attraction of its equatorial regions.

Such a progressive change of plane is found in the orbits of the satellites of the four major planets. Thus, for Neptune the approximate angle is 145 deg., for Uranus 98 deg., for Saturn (inner satellites) 27 deg., and for Jupiter 2 deg. It is also found in the case of the four inner planets, as far as is known, as determined by the inclination of their equators to the plane of their orbits. Thus, for Mars the angle is 25 deg., for the Earth 23 deg., for Venus the angle is unknown, and for Mercury, while undetermined, it is certainly very small, as is indicated by the drawings of surface detail made at Milan, Arequipa and Flagstaff. While the force producing this change must at the present time be almost infinitesimal, yet such would not have been the case in the past, when the planets were perhaps one hundred or more times their present dimensions.

If we take the great nebula in Andromeda as a type of our earlier existence, the planets being merely condensed masses revolving within and with the solar atmosphere, this atmosphere itself would excite a frictional force which would tend always to keep the same side of the planet toward its primary, while gravitation acting on the mass before it had separated itself from the spiral would tend to cause it to revolve in a retrograde direction. Thus in the earlier times it is very certain that these forces would be much more active than we find them to be at the present day.

Harvard College Observatory, November 7, 1901.

THE TERCENTENARY OF TYCHO BRAHE'S DEATH.*

ON October 24, three hundred years had elapsed since Tycho Brahe died at Prague, expressing in his last moments the hope that he might not appear to have lived in vain. When saying this he doubtless did not fear that the work he had accomplished might not turn out to be of permanent value, but merely regretted that the great goal he had looked forward to from his early youth, the complete reformation of astronomy, had not yet been fully reached. Could he have foreseen how brilliantly Kepler, who stood at his deathbed, was to complete the work, Tycho would have had no fear as to the lasting nature of his reputation.

It is difficult nowadays to realize that only a little more than three hundred years ago it was not a self-evident proposition that the science of astronomy could only be firmly established by observing the heavens systematically year after year, and not merely by taking an odd observation now and then. And yet this does not appear to have occurred to anybody before Tycho, as even Copernicus records very few observations taken during his long life, so that the values of most astronomical quantities had still to be borrowed from Ptolemy. But in August, 1563, the young Danish noble, then a student at the University of Leipzig, only sixteen years of age, commenced the series of observations which he carried on, with few interruptions, till the end of his life, thirty-eight years later. The instruments he used at first were crude enough, but already at that time the future reformer of practical astronomy was aware that a very inferior instrument may produce good work if all sources of possible errors are investigated and corresponding corrections are applied to the results of the observations. It is also worth noticing that the planets almost from the beginning claimed his undivided attention, so that the youthful observer had perceived that the existing planetary tables could only be improved if the computed places of the planets were systematically compared with observed places and the errors of the tables thus brought to light. Thanks to the great liberality of King Frederic II. of Denmark, Tycho was afterward able for more than twenty years, with the multitude of instruments of improved construction and assisted by a number of pupils, to follow the motions of the sun, moon and planets, while he at the same time, by his observations of a thousand fixed stars, gave to the world a catalogue of accurate positions of these bodies which took the place of the old catalogue of Ptolemy and held its own for more than a hundred years, until the use of telescopes and clocks of precision enabled Flamsteed to produce much better star places.

That Kepler made use of Tycho Brahe's observations to find the laws which govern the planetary motions and thereby to free the Copernican system from the eccentric circles and epicycles which it had taken over from the Ptolemean system is too well known to require repetition here. But Tycho did a great deal more than merely amassing materials for his successor. Not only was he the first observer who did not assume his instruments to be faultless but who studied their errors of construction, but he was also the first to investigate refraction and to attempt to correct his observations for it, and he succeeded in improving his instruments so much that it is difficult to see how a much greater accuracy could have been attained by succeeding generations, if the telescope had not been invented a few years after his death and if the application of the pendulum to clocks had not simplified many methods of observing. And Tycho was able to deduce many important results from his own observations. By showing that the comets observed by him had at most a very small parallax he proved that they were celestial bodies and not mere phenomena in the earth's atmosphere. Important as this discovery was, it is quite eclipsed by the splendor of Tycho's discoveries with regard to the motion of the moon. The ancients knew that the moon's orbit forms an angle of about 5 deg. with the ecliptic, that the two points of intersection (the nodes) travel round the ecliptic in the direction from east to west in about nineteen years, also that the earth is not at the center of the lunar orbit, and that the line of apsides completes a revolution (from west to east) in less than nine years. The great perturbation in longitude now known as the evection, by which the place of the moon may be put forward or backward as much as 1 deg. 16 min., was also known, having been dimly perceived by Hipparchus and clearly demonstrated by Ptolemy. But since his time no advance had been made (Sédillot's assertion that Abul Wefa discovered the variation has been clearly and finally disproved). The accurate and long-continued observations of Tycho Brahe revealed the existence of another inequality in longitude, known as the variation, which affects the place of the moon to the extent of 40 min., by which amount the moon is ahead of her mean place about three and a half days after new and full moon, and as much behind it about three and a half days after the first and last quarters. He also found the annual equation or the lengthening of the moon's period of revolution in winter and its shortening in summer. Finally, Tycho discovered the variation of the inclination of the lunar orbit and the irregularity of the motion of the nodes. After this series of brilliant successes he cannot have doubted that his observations were destined to reveal the mysteries of planetary motion, and already in 1591 he had commenced to suspect the existence of unknown complications in the motion of Mars, which he afterward alluded to in a letter to Kepler in 1598, in which he stated that the epicycle of Mars appeared to vary in size. Preparations had already been made for commencing the discussion of the observations of the planets, when an early death closed the life-work of Tycho and obliged him to leave the completion of it to Kepler.

The three hundredth anniversary of Tycho Brahe's death has been celebrated in his native land by a festive meeting of the Academy of Science at which the venerable King Christian was present, and at which orations were delivered setting forth the importance of Tycho's scientific work. At Prague, where he died, the monument over his recently restored tomb in the Teyn Church was again unveiled, and the interest which the citizens of Prague have always shown in the illustrious exile was manifested in various ways. But though Tycho toward the end of his life felt himself neglected in Denmark and left the country in order to enjoy the society of learned and congenial minds elsewhere, he never forgot the land of his ancestors and his birth, and on the titles of his last writings, as on his first, he described himself as "Tycho Brahe Danus."

The Copenhagen Academy has chosen a very fitting way of doing honor to the memory of the greatest scientific man Denmark has produced by publishing a facsimile reprint of his earliest publication, "De nova stella" (1573). Tycho's four principal works are found in all great libraries and are not unfrequently met with in the lists of second-hand booksellers. But the book on the splendid new star which appeared in Cassiopeia in November, 1572, is so extremely scarce that not a single historian of astronomy had ever seen it or even been able to give the title correctly until the writer of these lines gave an account of it in 1890. Tycho says himself that not many copies were printed and only a few were sent abroad, for which reason he afterward reprinted the more important parts of it in his larger work, "Astronomiæ Instauratæ Progymnasmata," on which he was engaged during the last fourteen years of his life and which was published after his death. But the whole of the original book, as it left the hand of the young author, is of great historical interest, and we are glad to see the fine reprint now issued, as the star of 1572 was so intimately connected with the progress of Tycho's work.

In a short Latin preface and a Danish postscript of thirty pages, M. Pechüle, of the Copenhagen Observatory, has given a short summary of the origin and contents of the book. Tycho's manuscript was an astronomical, astrological and meteorological almanac for the year 1573, in which he, after a lengthy introduction (to the almanac proper), had inserted his essay on the new star, another on the lunar eclipse of December, 1573, and a poem to Urania. After a good deal of persuasion by several friends, Tycho allowed the book to be printed in the spring of 1573, omitting, however, the main part of the almanac. It contains 53 ff. and has now been exactly reproduced in facsimile, but it has been collated with a MS copy partly written in Tycho's own hand and preserved in the Imperial library at Vienna, in which way a few corrigenda were noticed which are given at the end of the reprint. The book, which is beautifully got up, also contains a specimen of Tycho's handwriting and a copy of a very fine portrait, drawn with pen and ink, found in the Royal collection of engravings at Copenhagen and by some ascribed to the Dutch engraver Goltzius, by others to the painter Gemperlin of Augsburg, who came to Denmark with Tycho in 1575 and afterward painted the well-known portrait on his mural quadrant. To anyone acquainted with the contemporary literature on the new star and on comets this book will be of great interest, as it gives a very sober account of the startling celestial phenomenon which had given rise to a host of more or less worthless pamphlets and books, and shows that the want of parallax and motion proves the star to belong to the region of the fixed stars. At the same time, it is interesting to see that the author, who was destined afterward to give the death-blow to the Aristotelean idea of the atmospheric origin of comets, was still a believer in this doctrine when he wrote his first book, but also that he was already then thoroughly aware that the great desideratum of astronomy was an extensive series of observations which he hoped to be able to supply if health permitted and the necessary means were granted him.

Scania, the province east of the Sound, where Tycho was born, and the little island of Hveen, on which his observatory stood, formed parts of the kingdom of Denmark from before the dawn of history and till 1658, when they were torn from the country which had not sufficiently valued him and incorporated in Sweden. It is therefore natural that the recent anniversary of his death also attracted attention in Sweden, and in honor of the day the Physiographic Society of Lund has published a Festskrift (20 pp., 4to., with three plates), in which Prof. Charlier, of Lund, gives an account of the recent exploration of the scanty remains of Tycho's buildings on the island. The foundations of Uraniburg were laid bare, as also the floors of the half-subterranean observatory (Stellæburgum, Stjerneborg), but scarcely anything was found more than what the clergyman Ekdahl unearthed in 1823. It has repeatedly, in 1823, in 1868 after the examination of the site by d'Arrest, and now again on the present occasion, been pointed out that "something ought to be done" to protect the ruins from wind and weather, and we may add from relic-hunters also. If this was desirable formerly, when Hveen was a lonely place to which nobody ever went, it has become infinitely more important now, as the island seems to have become the common resort of Sunday trippers from both shores of the Sound, and it would certainly be safer to cover up the foundations again than to leave them unprotected. It has recently been suggested that the observatory might easily be rebuilt from Tycho's detailed and illustrated description and on the existing foundations and floors of the crypts, and no doubt this would be quite possible. But we confess we should prefer to see a large shed erected over the few stones that are left so that these venerable ruins could remain undisturbed. Most people would prefer looking at the ruins of Kenilworth Castle to walking through a sham castle erected on them and absorbing them.—J. L. E. Dreyer, in Nature.

* "Tychonis Brahe Dani die xxiv Octobris A.D. MDCI defuncti operum primitias De Nova Stella summi civis memor denuo edidit Regia Societas Scientiarum Danica. Hauniæ, die xxiv Octobris A.D. MDCCCCI." Pp. 16 + 54 ff. + pp. 30; 2 plates.

A NEW FIELD FOR KITES IN METEOROLOGY.

ALTHOUGH kites carrying recording instruments to a height exceeding three miles have rendered great services to meteorology at Blue Hill and elsewhere, they have been subject to the limitation of requiring a wind that blows at least twelve miles an hour. In certain types of weather—notably anti-cyclones—the winds are light and consequently observations with kites can rarely be obtained at these times. It also happens frequently that, while the wind at the ground is sufficient to raise the kites, it fails completely above the cumulus clouds so that the kites are unable to penetrate this calm zone.

By installing the kites and apparatus on a steamship, not only can kites be flown in calm weather, but observations may be made above the oceans where little is known about the conditions of the upper air. It is evident that a vessel steaming twelve knots an hour through a calm atmosphere will raise the kites to the height they would attain in a favorable natural wind, while the force of strong winds can be moderated by steaming with the wind. In this way, kites can be flown on board a steamer, under almost all conditions and probably more easily than on land, since the steadier winds at sea facilitate launching them. Wherever these observations in the upper air may be made, there is always a station at sea-level and not far distant horizontally with which to compare them.

To test the practicability of this method of flying kites, experiments were undertaken on August 22, 1901, with the aid of my assistants, Messrs. Fergusson and Sweetland, upon a towboat chartered for this purpose to cruise in Massachusetts Bay. Anti-cyclonic weather conditions prevailed, and a southeast wind blew from six to ten miles an hour, but at no time with sufficient velocity to elevate the kites, either from sea-level or from the summit of Blue Hill. With the boat moving 10 miles an hour toward the wind, and within an angle of forty-five degrees on either side of its mean direction, the resultant wind easily lifted the kites and meteorograph with 3,600 feet of wire to the height of half a mile.

While it is desirable to have a vessel that can be started, stopped and turned at the will of the meteorologist, as was the case in the experiments described, it is nevertheless probable that soundings of the atmosphere can often be made from a steamship pursuing its regular course, and such are about to be attempted by me on a steamer eastward bound across the North Atlantic. Although observations above all the oceans are valuable, the exploration of the equatorial region is the most important, since with the exception of a few observations on the Andes and on mountains in Central Africa, we know nothing of the conditions existing a mile or two above the equator. The need of such data to complete our theories of the thermo-dynamics and circulation of the atmosphere was urged by the Russian meteorologist, Woeikof, at the Meteorological Congress in Paris last year. North and south of the equator, within the trade-wind belts, kites might be employed to determine the height to which the trades extend, and also the direction and strength of the upper winds, concerning which the high clouds, rarely seen in those latitudes, furnish our only information. In order to deduce the velocity of the upper current from the resultant velocity recorded at the kite, it is necessary to ascertain the direction of this latter force, which could be done from the orientation of the kite.—A. Lawrence Rotch, in Science.

MISSING LINKS.*

THE "missing links" in evolution have been very much discussed. Many hold the main argument against evolution is, we should find to-day all intermediate forms: they should be connected together in a perfect series—if not in the living, at least in the extinct forms there should be connecting links between the species to produce a perfect chain of evidence for evolution. As a matter of fact there are very few such perfect connections known, either among fossil or living forms. Concerning the fossils the reason for that is, very few animals are capable of preservation: those that are, are generally not preserved. Among the living animals, the main reason for the absence of connecting links is that the struggle for existence would tend to kill them out.

Take a series of geological strata lying upon one another; suppose in time a species arisen here whence developed other species through the different ages—each stratum representing a period of geological time during which new species were forming. Some of these would reach the present age (the uppermost stratum), but the majority must become extinct in the earlier; if we add to that the local changes and consider that in most cases only a very few would be preserved as fossils—perhaps in this stratum not a single one, nor here, nor there—the result would be a jumble of forms of different geological periods; and it is those we have to piece together as best we may from the evidence of comparative anatomy to show their relationships.

As to the ancestry of the birds, first of all the plumage and the peculiarities in the hind leg bones and in the wing bones and a few bones in the skull, make it entirely different from any other animal. The only group of animals to which birds could be said to be related in any way would be the group of the reptiles: the lizards, crocodiles, snakes and tortoises. Comparative anatomy reveals many points of similarity in bird and reptile. It has generally been assumed that birds have been derived from reptiles; but that was only an assumption: there was no proof for it until the discovery some thirty years ago of a fossil bird from the Jurassic period in the Stadthofen marl beds of Germany. There were found: first, a single feather; then a whole skeleton (bought by Prof. Owen for the British Museum); later, a much finer skeleton (now in the Berlin Museum). All that is known of these birds are two feathers; one rather incomplete, and one fairly complete, skeleton. That skeleton is very interesting as being intermediate in structure between a bird and a reptile—showing structures which beforehand we had to assume would be found eventually—must have existed—between a bird and a reptile.

Such is the exinct bird archeapteryx, the first thing noticed in whose structure is a long skull without a beak proper; on the upper jaw a series of very sharp teeth—no bill, but teeth; and three teeth also in the lower jaw. The neck contains the series of neck vertebrae; on that follows the shoulder girdle; and in the arm structure the most interesting thing is the hand, or what in birds is called the wing. From the shoulder there goes out the upper wing bone, which is the

* Abstract of a lecture delivered at the Wagner Free Institute of Science, Philadelphia, by Prof. Thomas H. Montgomery, of the University of Pennsylvania. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

same as our upper-arm bone—the humerus—connecting with the two smaller bones of the forearm; then two little wrist bones, and then what is very peculiar for the archeapteryx—fingers, entirely separated from one another. The skeleton has three fingers, each with three joints, each ending in a claw separate from the others. In the living bird those fingers are grown together, not separated, not ending in claws; but in the archeapteryx there are three entirely distinct fingers not covered with feathers and which constituted a clawed hand projecting from the wrist out upon the mass of feathers wherewith to climb and very different from any living birds. The only living bird known using its wings in climbing is a curious South American species which, when young, walks about with the tips of its wings and on its legs, i. e., on all-fours. That is the only bird that has kept up this mode of progression known in the archeapteryx. In the archeapteryx, feathers come from the forearm bones—no feathers in the hand region; while in the living birds that is also entirely covered with feathers.

Archeapteryx has a tail made up of some twenty or twenty-one vertebrae; and on each one of those vertebrae is a single pair of feathers coming out in this way—just one pair of feathers from each vertebra. The feathers, of course, are barbed, with their veins as in the living bird. In the modern bird's tail are very few vertebrae and all of the rearmost ones fused together to form one piece: that is, the common well-known Pope's nose of the Christmas turkey—this single piece consisting of eighteen or more fused together. All of these are separate in the embryological modern bird; but before leaving the egg they fuse together to form one piece. In the archeapteryx all those are separate, and instead of the tail of the living bird there comes something very similar to the long tail of some of the lizards.

Another peculiarity of archeapteryx is a curious little ring of bones around the eye socket looking like a pair of spectacles: that is a reptile character, entirely; but in having feathers and several other structures, with all the bones of the head firmly fused together, archeapteryx is undoubtedly a bird—one which has preserved a few of its own ancestor's (the reptile's) characters, particularly in the wing structure—that clawed wing representing the old structure of the forefoot of the reptile. Imagine in a reptile the first toe lost (the first finger, that is) and then the fifth (the outermost): those three claws would remain just like the claws of archeapteryx; and if feathers should grow out—those two outer toes go—that would be absolutely in every detail like the arm and hand (or the wing, we call it) of archeapteryx, and very different from that in a living bird.

A very interesting point comes up in the structure of the hind foot of birds and reptiles. The hind foot of any reptile has, besides the bones that make up the toes proper (the phalanges) the long bones between the little wrist bones and the finger bones which are known as the metatarses. In one of the highest mammals, as in this hyena, you see the little wrist bones on the fore feet; then the metacarpals; here the metatarsals; then the toe bones and the finger bones. On the bird's skeleton on the hind foot there is one long bone here; then the toe bones; and the question is, what becomes of the little wrist bones that we find in all other land vertebrates? In the hind leg of a reptile there comes down first of all the thigh bone articulating with the hip; the bones of the lower part of the leg; then two rows of little bones—four bones in each row. From those bones run out the long metatarsal bones and finally the little finger bones of which there are usually three to each finger, ending in most lizards, or in most higher animals, in claws.

In a bird's leg, on the contrary, we would see a thigh bone; the two fore bones of the lower part of the leg (a little hind one corresponding to this fused with the larger front one) then immediately on this hand following, the toe bones (none of those other bones at all which are represented in the lizard's skeleton)—having here four bones—three in front and one behind. What has become of these two little rows of wrist bones? It would be a strange thing if those had dropped out of the development altogether, because those are found in the frogs and the newts; in the lizard group; in all the higher animals: these little bones here in the wrist and correspondingly back here in the ankle; we have them in our hand, also in the wrist—two rows of four bones each in the same place; and if the bird has been derived from the lizard (and we know the lizard did have those two rows of four bones) what has become of those bones in the bird?

A study of the embryology of the bird shows this. The upper of the two rows of small bones has fused with the end of this bone, making a union with it in the early stage; the lower row has fused with the end of this bone; just as if in our forearm, with the two bones of the forearm, the radius and the ulna, this first row of little bones had fused and if with these long bones here, the metacarpals, the other row should fuse. That would be exactly the structure in the birds; so there are no lost bones there; that is just a fusion together.

Why, after all, should a bird be different from a reptile? The one most obvious difference is in the outer covering: in the birds, very light feathers; in the reptile, heavy scales, or heavier armored scales; and in the reptiles the bones are not firmly fused together. This reptilian skull reveals the sutures between the bones thereof; in the bird's skull, on the contrary, at a very early age all the bones fuse together very firmly, and in addition to that fusion, all the bones become very highly pneumatic. You can always tell the bird's bones by the very large air cavity it has to give it lightness; and another point marking the bird structure are these vertebrae in the dorsal region so tightly fused together that they do not allow any bending in any direction. In the higher mammals there is no fusion there at all; also in the lizards, they are perfectly pliable there. Evidently the difference in that structure has arisen in this way: the bird changed from a reptile as soon as it took to living in the trees, probably. The first habit of living (crawling like a reptile on the ground and up trees) was abandoned; then perhaps it began to drop or jump from tree to tree as we find in present forms (e. g. the flying squirrel and the flying foxes of the eastern islands—those forms which cannot fly but which can pass certain distances); with the gradual development of the feathers to greatly aid in flight (a character which would be preserved by natural selection as a beneficial one), there would also be a great advantage to the bird in having its whole skeleton as light and strong as possible; so there would gradually take place a thinning out of the bones of the hard skeleton (the bones getting much thinner and relatively stronger) with, in the regions that are the fulcra for the flight muscles, a great development of these dorsal vertebrae and the formation of a great breast-bone such as no other animal has (this is an enormous breast bone in the ostrich: no other group of animals has its equal) all for the attachment of muscles of flight.

The principal line, therefore, in which the bird has developed differently from the reptiles is in the formation of structures adapting it for flight; and whenever the bird gives up flight there is immediately a change in those structures. There are two groups of birds known: first the great group (constituting the vast majority) of those whose breast bone has a marked ridge on it; then the group to which the ostrich, the emu, and the cassowary belong, with the breast bone perfectly flat (without any ridge). For a long while this second group of birds was looked on as the primitive: it was supposed that they had not yet learned to fly—that they were the most ancestral forms; and since they had not learned to fly they had not yet developed a great crest here for the attachment of flight muscles. All great, bony ridges are developed simply under the pulling action of muscles. If there is no muscular attachment on a bone, that bone is perfectly smooth; and wherever ridges are present upon the bones, or any prolongations, there is where the muscular attachment is greatest. So on the skeleton, by the eminences and prolongations, you can read the insertions of very nearly all the muscles. If there were great flight muscles present in the ostrich there should be a great ridge on the breast bone to give them a greater surface for insertion than afforded on a perfectly flat bone; and on that ground the ostrich was looked upon as a primitive bird that had not learned to fly, and lacked a well-developed sternum.

In archeapteryx, in the Berlin specimen first described, all the bones of the body were described excepting the breast bone; from the thin plate of clay in which the bird was embedded, all the substance was gradually dissected away; but the breast bone lay embedded in such a position that Prof. Doremus, who was describing it, did not have the courage to work it out, fearing he would break up the whole piece. Finally he succeeded, and it was found to be a crested breast bone like the living bird. That seems to settle the question, then, as to whether the ostrich or the other group of birds is the more primitive. Probably, since the archeapteryx has a ridge or crest to its breast bone, birds have had for a long time; so it is very probable that the ancestor of the ostrich had it, and that the ostrich has lost it through disuse; that is, through lack of use it has deteriorated; and that would be a very simple thing in the case of a bone: the wing muscles cease to be used; the bone ceases to be drawn out into a long crest; and that continuing through the ages, the bone after a time would be perfectly flat, because there would be no wing muscles moving upon it at all to change its form—to pull out a crest, it being a pulling action of the muscles upon the bone while the bone is young and in a plastic state: that is, while still more or less cartilaginous the muscles start to act upon and draw it out. To make up for that there is in the ostrich a corresponding development to take its place in the bones of the hind leg—a development present in like degree in no other except these great running birds.

There is another link: that is, what the ancestors of the hair-bearing animals were. In the vertebrates these main classes are distinguished: first, the group of the fishes, which is a sort of a composite name for them, because they are made up of a great many groups having no relation to one another; then the amphibians (frogs, newts and toads); the group of the reptiles; the birds; then the mammals—all the animals which have the body covered with hair: mammals from low forms like the ornithorhynchus and the opossum through the higher forms. The question is, what is the ancestor of the mammals? The birds, until there was a connecting link found, seemed to be separated from any other group; then the archeapteryx was made known; but the lowest living mammals known for a long time were forms like the kangaroos and the opossums—a very old group of animals, found in early geological times; but there was a great distinction between a kangaroo, or an opossum, and anything like a lizard or an amphibian or a fish. The forms which have thrown more light on the ancestry of the mammals are one native in New Zealand and Australia—the ornithorhynchus, or duck bill—and another, very closely related, known as the echidna, from New Zealand and New South Wales: forms half-way in structure between reptiles and mammals.

A shoulder-blade or scapula, with the collar bones, constitutes the shoulder region of the higher mammal. The lizard has a great deal more complex bone in the same place. The ornithorhynchus has a breast bone, but of a very peculiar form—a series of bones growing together, exactly as in the mammals proper, where the ribs are all fastened to a median bone (the breast-bone) which is jointed that way in all the mammals, differing only in the number of pieces and how closely those pieces may be united together. That breast bone is found also in ornithorhynchus; but in front of it is found another breast bone, of this form: they are joined up here to the clavicles—two great arched bones crossing one another; then passing from this joint comes down another bone which the mammal does not have—the coracoid bone, found in birds and reptiles; here a pre-coracoid bone; then joining at this place the upper arm bone.

Now, in the birds here come the two collar bones (the mammals have those), but just behind them these two large bones which give people generally so much trouble in carving because they don't happen to remember where they join the breast bone: those are reptile bones and bird bones, but no mammal has them; yet those are the bones that the ornithorhynchus has; so the ornithorhynchus is like a mammal in having hair—no reptile has hair; it is like in part of its breast bone; but on top of the jointed breast bone that it and the other mammals have, it has a string of bones which no other mammal, but which any reptile, has. Then in the hind part of the ornithorhynchus' body, from the pelvic arch two long bones run forward not present in the ordinary mammal but which most reptiles have; but the most interesting thing perhaps about this animal which looks so much like a mammal on account of its hair and general form is that it lays eggs. That is a reptile character—it has reproductive organs like the reptile; it lays eggs, and from those eggs the young are born as in the case of the bird, the snake, or most lizards; so we have in this ornithorhynchus and its close ally, the echidna, two forms which fortunately are still living which are, we might say, in some points, as in the skull and in the hair and in the structure of the feet, mammals—entirely mammals; in all other points they are reptiles. Than either of these forms there could hardly be desired a better example of the connecting link; their reptile character is so strong that despite their external appearance it is evident they are nothing but haired reptiles. There is now a party of English naturalists who have been after those for the study of the embryology; it is important to have them breeding in large numbers; and it will be very interesting to see the development of the egg when the memoirs are published—how nearly it coincides with the development of the egg of a bird or of a reptile.

Perhaps of all the links that geology shows, there is a more perfect gradation between the different forms in the ancestry of the horse than in any other group of animals excepting the shell fish. In a fore leg of the living horse are the scapula, the humerus (the upper arm), the forearm, and on the end thereof, only one toe—the most striking thing about the horse. In the hind leg also there is just one toe. Here is a forearm. In life in a horse all the part from here up around the shoulder is hidden: it is what is generally called the ankle; and what we generally call the hock is really where the fingers come off from the back of the hand.

You notice in there one toe and a little splint bent on the inner side here—a slender one; sometimes a little one on the other side present, which suggests that there might once in the horse have been more than one toe. In almost all mammals there are five toes. The hyena's fore foot has four toes, and a small abortion here—a little joint of a fifth, very small in the hyena, but large in most other groups. Sometimes there are only four, as in the cow, two large ones in front, two very small ones behind; but they are shown in the pig; though as a general rule there are five toes on the hand just as in the reptiles and the mammals (as in the ornithorhynchus and in our own hand); so that the problem arises, if the ancestor of the horse could be found, would it have more than one long toe: if so, what toe would this be?

The oldest horse known is from the early Eocene beds of North America, and has four toes. Of the recent period in geological time we distinguish the lowermost beds as the Eocene; then the newer beds as the Miocene, Pliocene, and Pleistocene, and then the most recent—that is, the living age. The first (Eocene) horse was found at a time long before any of the present horse species had been formed—long before man had come: in fact, man could have been formed only in a very modern period of the recent age.

The fore foot of that Eocene horse showed four toes in this way: first a long hind toe with three joints (the end one with a little hoof); then a toe at the side a little slenderer (not nearly so long, and also with a little hoof); so in this original ancestor we had a horse practically with four hoofs or four separate claws—a foot, that is, very much like the foot of an animal of this kind: instead of a little claw here, there should be a little hoof—a foot like the present elephant's foot where each toe ends in a special little hoof. That was the original horse; and now a little toe up there very much smaller. The thumb was missing in the horse of the oldest type known, which we can determine by the peculiarity in the joint up here. The Eocene form of horse we have denominated Eohippus, and it was about the size of a dog. As we leave the Eocene the eohippus is no longer found, but other types of horse succeed. The next one found has still the middle toe (the third), with its joints, and the hoof on the end of the joint growing larger; only the two side toes; but the fifth toe has disappeared: this toe has gone altogether—no trace left of that; so what is left then of the horse of this lower period of the Eocene will be toes 2, 3, and 4: the fifth has left already. Here it is pretty small—is leaving; when we get to the next geological period the horses of that time which have arisen from these have lost that fifth toe entirely.

As we pass to the middle region of the Miocene there comes another horse taking the place of this one and obviously a direct descendant of it, having the middle toe of a little stronger, thicker bones, larger joints with a larger hoof development; that hoof is getting much larger, and now these second and fourth toes getting very much slenderer, to a stage at which they could not have been of any service in walking at all: they are almost useless, still enough was left—a little hoof in that way; this being again second, third and fourth toes.

Up in this Miocene, and at the end of it, the Pleistocene, there passes right through there (from the lowermost strata into the more recent), a series of fossil forms that follow upon one another closely—a perfect evolution series where those second and fourth toes gradually get smaller and smaller till up in the Pleistocene period a horse is left with that middle toe larger and stronger—also its joints—with a comparatively large hoof developed on that; all that is left of these side toes two of these little splints without any hoofs on them and without any joints; and when you compare that with—taking its place in recent times—the modern horse, the latter shows one little splint and you usually won't find that in the horse skeleton: in fact, it is only an exceptional horse showing that: most individuals do not show anything but the middle toe. So you see here in the horse's foot—horse's hand—what is left is the third toe—the middle toe—of the ancestor.

What had become of the first toe—the thumb, that is—of the horse? Remember, we started with this Eohippus with four toes—second to fifth inclusive. Now there must have been an ancestor to that: more, we know from comparative anatomy they had five toes (or five fingers): that is, a thumb in addition to these four simple fingers. That has been very well worked out on certain skeletons in a very interesting animal, the connecting link between forms like the cats and dogs on the one hand and horses on the other, and perhaps related to such a group as the cows with their split hoofs.

When this was developed along one line it became a horse; so that the horse had left only these four toes from the index finger to the little finger; and at the modern day the horse finally has nothing but that middle finger, which was the original third finger of the hand. There is a curious thing to notice in the history of horses: that the wild horse which was found in the western part of North America about 150 years ago by some of the earlier travelers and explorers, was not indigenous to North America at all: it was simply the running wild of some of the horses that had been brought over by the Spaniards. The Spaniards came over not before the fifteenth century, and prior to their arrival there were no wild horses at all in North or South America; and what is more, there had been no wild horses in North, South, or Central America in the knowledge of man on this continent: that is, during the time that man was present on this continent. That is proved very well, because the natives of North and South America have absolutely no myths nor rock-drawings relating to horses. We find in some of our rock-drawings and paintings the old mastodon, the primitive elephant, and some other forms that have died out hundreds—perhaps thousands—of years ago: those men remembered and drew what had been actually seen by men within the time of the human race; but the horse never had been—there is no reference to them; they evidently were extinct in America; there were no horses in America at the time the Spaniards came, and there had not been for a long time before that. Notwithstanding all this, the horses arose first in North and South America: the earliest horses that were ever found in geological time were the North American early Eocene period horses (never found in Europe at all); but at that time there was probably a continuous land connection between North America and Asia by way of the Aleutian Islands, and from the evidences that we have it seems probable that the North American horses—the orohippus (descended from the eohippus)—spread gradually all over the North American continent, found its way by means of this isthmus over into Asia, and then down through Asia and Europe; and that gave rise to a line of horses over there. So we can distinguish two parallel lines in the development of the horse very, very interesting: starting with the four-toed type in the lower Eocene of North America, some of those horses remained in North America and developed a series of genera in this way up to a horse that lived in recent times. Then from this early horse some went over to Europe and developed there in a chain that shows a very parallel development to the chain in North America: that is, these two genera won't be quite the same, but nearly the same, and as in the North American horses had just the same history in North America and Europe, but with this difference: America was the home of the horse, as America was also originally the home of the camels. America being originally the home of the horses they arose here and from America got into Europe; though very early in the recent geological period horses died out entirely in North America, so that the horses which we have living now are descendants of European horses whose ancestry, if we will trace far enough, goes back to the North American horse.

Also, in this line of development of the horse, we will mark that apparently of living horses there are two species. They have been bred together so much that the difference between them can hardly be recognized; but undoubtedly it seems there were two: there is a smaller horse—a lighter, quicker horse, that seems to have originated from a Post-Pliocene horse of Asia. That is the horse from which the modern Arabian horse had descended; while another horse from which most of the draught horses of to-day (the larger and stronger horses) have descended seems to have arisen from a little different fossil ancestor from the Arabian horses—one that was found fossil first further west in Europe, along the Mediterranean; but now to-day two horses are bred together and are kept up; and we find that all the other present undistinguishably those two forms. It is a very curious history to keep in mind that horses should have originated in North America; North America giving the line to Europe; then from Europe we are getting back, really, again our own old horse. Camels arose, as Prof. W. B. Scott has shown by the aid of the Patagonian material that has come into the Princeton collection, near the Andes in South America; there was an enormous group of species living at that time; then there was a migration of those probably by way of the same land isthmus, where the Aleutian Islands now are, to Europe; then the American stock died out, and now the only living camels are found in Asia; and yet to-day the Americans have been trying to bring camels back to the Great Desert of the Southwest again; so that is a bringing back of the camel to its original home.

GIGANTIC SALAMANDERS IN THE BERLIN AQUARIUM.

Potassium Permanganate for the Disinfection of Wells.—For the disinfection of wells, Délorme has successfully employed potassium permanganate, using 5 grammes per liter of water. The color of the salt is readily taken away by throwing a few handfuls of crushed coal into the water. A well water, for instance, which before the disinfection contained 112,000 germs in a cubic centimeter of water and spread a nasty odor, only held 150 bacteria per cubic centimeter after treatment with potassium permanganate.

The presence of potassium in the drinking water, one of the most unpleasant side-effects of this mode of disinfection, and which has prevented its general adoption, need not be feared, as has been shown by chemical investigations. Moreover, a lime salt may be used, without disadvantage, instead of the potassium salt. The ease and rapidity of the process—in three to four days the disinfection is accomplished, the coal has settled and the water is perfectly clear—as well as its cheapness render it very commendable.—Neueste Erfindungen und Erfahrungen.

GIGANTIC SALAMANDERS.

THE gigantic salamander was discovered on the island of Hondo, Japan, seventy-five years ago by the German explorer Pr. Fr. v. Siebold, in whose honor it was given the name of *Sieboldia maxima* or *Megalobetrachus Sieboldi*. For the past thirty years specimens of these salamanders have been on exhibition in the Berlin Aquarium, where they have always formed a center of attraction, partly because of their uncouth exterior, reminding one of similar extinct species, and partly on account of other peculiarities. At present the Berlin Aquarium possesses four fine specimens of these amphibians, which occupy three spacious tanks, two that treat one another with proper respect having been allowed to remain together in spite of the general rule to keep the salamanders separated, which has been enforced since one of them was badly mutilated by a voracious companion several years ago.

Each of these four specimens is more than a yard long, the largest one having more than doubled its length since its importation in 1883. This is 4 feet long, including its tail, which is 21 inches long and 7 inches thick, thus far outmeasuring the maximum length of 3 feet 8 inches given in many books. In this connection it may be stated that the writer's observation, covering a period of twenty-seven years, has led him to the conclusion that the growth of a salamander is comparatively rapid until it has attained a length of from 31 inches to 39 inches, but after that it is very slow, the animal then gaining more in other dimensions; but it must be acknowledged that even after one of these creatures is fifty years old it does not cease to increase in length.

The second specimen here is 3 feet 5 inches long, and the third 3 feet 4 inches, while it weighs 49 pounds. The fourth could not be accurately measured. The little figure at the left-hand side of the engraving represents a German water newt, which was placed there for purposes of comparison as to size.

The color of these salamanders changes as they grow older, the greenish brown of the ground color changing to an uncertain gray brown and the black spots to dark gray. The points of the toes and the irises of the little eyes are whitish. They shed their skins several times each year, just as does the German water newt. The skin loosens first around the jaws, then along the belly, and then is pushed back or the creature seizes it with its mouth, pulling it off like a shirt. The cast-off skin is generally eaten by the former wearer. The sluggish, lazy temperament of these animals corresponds perfectly with their helpless appearance. They scarcely move except when pushed with a stick or the net used by the attendant in cleaning their quarters, or when a fish is brought within the limited circle of their

vision, when they will snap at the intruder with a vicious forward or sidewise movement of the head. It seems to be only by accident that one of them ever catches a fish, and therefore, when in captivity, the salamander is fed on dead fish which the attendant holds on a stick within its range of vision. These creatures prefer dark places, where they will, if necessary, make themselves more comfortable by pushing the gravel away from under them.—For the accompanying engraving, as well as the above data, we are indebted to the Illustrirte Zeitung.

BICYCLE ARTILLERY.

THE bicycle artillery corps is a body of recent creation which seems to be destined for a great future. In fact, it is now in a fair way of doing reconnoissance

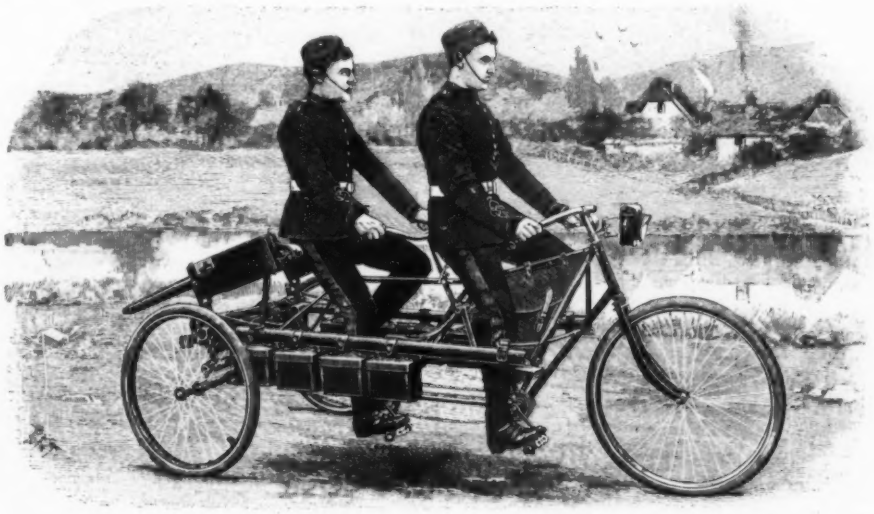


FIG. 1.—THE MAXIM MACHINE GUN MOUNTED UPON A TRICYCLE.

duty in place of the cavalry. How much superior, indeed, is a bicyclist to a horseman. He is always ready to start immediately, while the latter has to wait to harness and saddle his steed. Then, again, the bicycle is faster than the horse, and requires less care; and the fact that no food is needed constitutes an appreciable advantage in a campaign in which so many difficulties are met with in the way of procuring forage. It is true that the bicycle can be used only upon roads, but in France and Germany the by-roads, large and small, are so accessible that the use of it is capable of being made general.

Moreover, the recent maneuvers in France showed how valuable this machine was. Owing to this useful auxiliary the troops were able to maneuver with a directness and precision until then unknown. It is therefore evident that military bicyclists are in a fair way of securing an important position for themselves in the army, as they are naturally destined to become *the* scouts *par excellence*.

In reconnoissance duty it is necessary to proceed as far as possible without being arrested by slight obstacles. But even should a serious but surmountable obstacle happen to be met with it may sometimes prove advantageous to break it down in order to obtain a free passage. Now, the carbines with which the bicyclists are provided would not suffice to effect such a result, and hence the necessity of equipping the scouts with more powerful weapons. The simplest process that offers itself to the mind is to provide the bicyclists with machine guns, which are both light and powerful. One of these weapons, in fact, does not weigh more than about thirty pounds, and its ammunition consists of nothing more than infantry cartridges. It is capable of easily firing 600 shots a minute, with a precision that is so much the greater in proportion as the gun mount is steadier. So it is estimated that a well-served machine gun is equivalent, as regards efficiency of firing, to half a company of infantry.

Such considerations have led the large English house of Vickers, Sons & Maxim to devise a machine gun tricycle, which we represent in the accompanying engravings. Two Maxim guns are mounted upon the tricycle, the weight of which is 120 pounds, while that of the two guns is 54, that of the tripods 106, that of the spare pieces 8, and that of the 1,000 cartridges, with their case, 86. This constitutes a total weight of 374 pounds, to which is to be added that of the two men who ride the vehicle. It seems that such a tricycle is capable of running at a high rate of speed upon a level. Upon up-grades, however, it is necessary to dismount and push the machine.

The putting of the gun into and out of battery is very quickly effected, say, within the space of less than two minutes. It is clear that such a machine might easily be lightened. In the first place, it would be possible to provide it with one gun, so as to reduce the supplementary weights one-half, say, by 128 pounds. On another hand, it would be easy to distribute this latter weight over several machines, instead of placing it upon a single one. The machine gun would be carried by one machine, the tripod by another and the ammunition by a third.

Three tandems would not permit of any increase in the weight being perceived, and in this way it would always be possible for the gun to accompany the bicycles of the scouts. The three tandems designed to carry the gun and its accessories and ammunition should not, in our opinion, be tricycles such as the Vickers Company proposes the adoption of, since the tricycle is a machine that cannot attain a very high speed or adapt itself to the difficulties of the road. But the English company has prepared it for the execution of the firing, and the form adopted, which serves as a tripod for the machine gun, is shown in Fig. 2. But such an arrangement is in nowise obligatory, and the weapon can be manipulated better upon an independent tripod. It would be our opinion, then, that the machines for carrying the gun and accompanying material should be tandem bicycles, which have the advantage of being swifter, safer and more flexible.

It seems from the experiments that have been made that it does not take more than two minutes to put the gun in battery, and the same length of time to put it back upon the machine. If we reckon upon firing one shot a minute it will be seen that it will take about five minutes to deliver a volley of a thousand balls against an enemy that it is desired to surprise. Upon the whole, the use of the Hotchkiss machine gun, which has been adopted for the French army, and with which a few battalions of chasseurs have been equipped, is indicated in the service that the bicycle companies are destined to perform. Experiment has already been favorable to military bicyclists almost everywhere. The question is one of genuine importance.—For the above particulars and the engravings we are indebted to La Nature.

RECENT EXPERIMENTS WITH SOUND SIGNALS.

IN an appendix to his treatise on sound, Prof. Tyndall gives a communication from Prof. Kean, the Rector of the University of Virginia, who described in brief outline a remarkable instance coming under his notice during the American war, of the inaudibility of heavy firing when within easy sound range. A battle was in progress at Gaine's Farm on the Chickahominy, a river which at that point runs in a valley of one and a half miles from hilltop to hilltop. Across this valley Prof. Kean, in company with Gen. G. W. Randolph, watched the musket fire of both lines of combatants and the flash of guns as the batteries of artillery on both sides came into action and began to fire rapidly. Yet he writes: "Looking for nearly two hours, from 5 to 7 P. M. on a midsummer afternoon at a battle in which at least 50,000 men were actually engaged, and doubtless at least a hundred pieces of field artillery, through an atmosphere optically as limpid as possible, not a single sound of the battle was audible to Gen. Randolph and myself." The professor offers as an explanation that the deep broad valley was partly swamp, shaded from the declining sun by hills and forest on his side. Some parts of the valley, too, were cleared and in cultivation, some not. Thus, as he puts it, "there were conditions capable of providing several belts of air varying in the amount of watery vapor, and probably temperature, arranged like laminæ at right angles to the acoustic waves as they came from the battlefield."

I have recently received much fuller details of the above remarkable phenomenon from a field captain under Gen. Lee, who was at the time attached to Magruder's division, and who has drawn a careful sketch of the battlefield and of his own point of observation. My informant states that the farm was in reality only a mill, and that the engagement had begun by a gradual advance on the previous day, when he himself watched the conflict from the branches of an oak tree about one mile from the mill across the valley. On that day, the guns being as yet some miles distant and screened by forest trees, their sound appeared somewhat muffled. Presently, however, Lee's troops broke into the open, and seeing their foes retreating raised their war cry, "the rebel yell," which my informant heard distinctly, though "more than five miles away."

The next day, when my informant occupied the same point of observation, the combat had approached considerably nearer, being now centered round the hill on which the mill stood. Yet, though 60,000 men on both sides were firing as fast as they could load, and over a hundred guns were equally active, not the faintest sound could be heard.

It might be supposed that a parallel to this remarkable account is not to be looked for in our land, where circumstances of climate and country are alike different. Yet only lately we have had most carefully collected and trustworthy evidence of an acoustic marvel quite as great in its way. We may fairly assume that the minute guns marking the funeral progress of our late Queen across the water at Spithead were intently listened for by thousands of people in that quarter of England. Yet though the time of that mighty salute was accurately known, it appears that in the immediate neighborhood, say, at a distance from ten to forty miles, the firing was "almost or quite inaudible." This is a simple statement that has been repeatedly made in the public press, and to my knowledge has never been gainsaid.

At first sight it might, indeed, appear that there is no comparison between these records and that of the entire extinction of the sound of a cannonade at the distance of only a mile or two across the valley of the Chickahominy, but the remarkable nature of the sound phenomenon observed on the 1st of February, 1901, grows when we glean the fact that the lost sounds manifested themselves again at a great number of vastly more distant stations. Records gathered with much care and discrimination from all districts on English soil, go to show that at many places in Surrey the firing was distinctly heard, while at Sutton and Richmond Hill windows actually rattled, as they did also at Tunbridge Wells and Ashford in Kent. Further out yet, indeed, almost twice as far, as, for instance, in the neighborhoods of Cambridge and Peterborough, there is strong evidence that the sounds, unmistakable in their nature and interval, were detected.

It should be mentioned that inland the wind was generally opposed to the direction of the sound, and it has been suggested that the sound waves traveling up the wind were at first carried over the heads of the observers, even those occupying high ground, and this phenomenon would be accounted for by a theory propounded by Prof. Stokes in 1857. This theory assumes that in general the rate of motion of wind increases with altitude above the earth's surface, and that in consequence a sound wave moving against the wind would have the upper portion of its front pushed back more than the lower portion. Thus the direction of motion of the wave being always at right angles to its front, would constantly tend to slant obliquely upward. In accordance with this theory (as Lord Rayleigh has pointed out) sounds inaudible on the ground up-wind should still be caught overhead, and, indeed, Tyndall made some experiments in this direction. He took a hinged ladder out on to Wimbledon Common and caused a bell, which was being constantly and uniformly struck near the ground, to be gradually withdrawn to leeward until he failed to hear it. He then ascended the ladder, when the bell again became audible. It of course needs no pointing out that in this experiment special precautions are necessary to guard against personal error. When the ear has been for some time listening intently for faint sounds at the limit of audibility, it becomes tired and its sensibility blunted, and the faint sounds may be wholly lost, simply through fatigue. It is conceivable, therefore, that the mere act of climbing a ladder might give such rest to the ear as would enable it on that account alone to again hear sounds which a little time before it has ceased to perceive. Doubtless Tyndall would have guarded against such an error, but it is to be regretted that no other sounds were experimented with, and no greater height ascended than that afforded by portable steps. It would almost seem also that in this experiment there is neglect of the fact that a wind of any

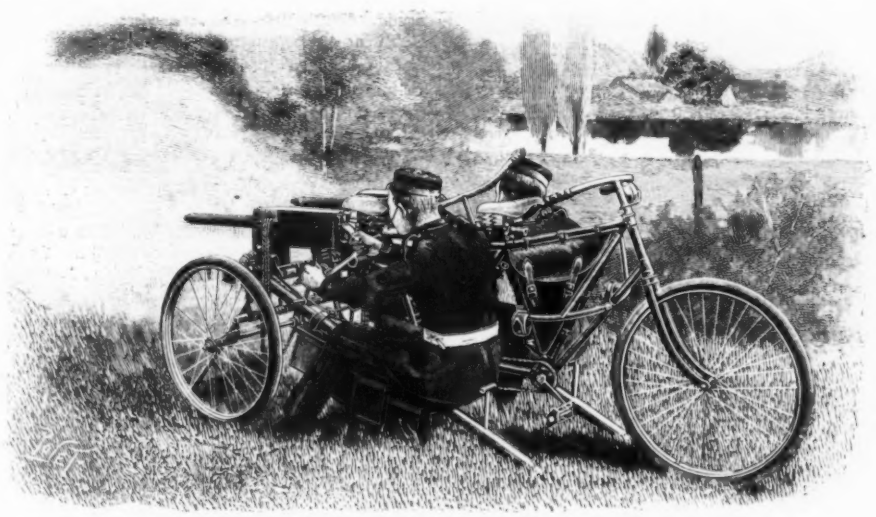


FIG. 2.—THE MACHINE GUN IN ACTION.

force causes a rustling as it sweeps across herbage, which would be more distracting according as the listener is nearer the ground.

It occurred to me recently to experiment in the same direction as that just indicated, but with a larger series of practical tests, and with such as should introduce the results, not of a single observer, but of many. Moreover, as the instances of the anomalous behavior of sounds given above had reference to those of explosive reports, I determined on experimenting uniformly with the standard four-ounce guncotton fog-signal which is in common use, and which may be relied on as being uniform in manufacture. My experiments, which will be given in order, were occasionally conducted in day hours, but more often when night was well advanced, so as to eliminate as far as possible the chance distracting sounds necessarily associated with the hours of busy life.

The first trials, in which I was assisted by Mr. J. N. Maskelyne, were carried out on a level common 500 feet above the sea, for the most part destitute of trees, but clothed with gorse and bracken. The night was one of dead calm, during a continuance of warm, dry weather. Numbers of observers were stationed at distances ranging up to six miles, and the guncotton charges were fired in pairs, one on the ground, the other by aid of a rocket in the air, the observers, however, being ignorant of the other firing. The results went to prove that (1) other things being equal, the audibility increased with the altitude of the observer's station: (2) in most, but not quite in all cases, the rocket charges were the better heard; (3) at each station, in spite of still atmosphere on the ground, the several reports differed greatly both in the initial report and in the nature and duration of the after sound, which prompted the supposition that though otherwise imperceptible, there were varying currents and commingling of air sensibly affecting the results.

The next trial was made over a greatly extended range, and the ground was so chosen that as few obstacles to sound as possible should be presented by intervening objects. With a small party of observers I repaired at night to Salisbury Plain and took up my position on the top of the Beacon Hill near Amesbury, while another party occupied the crest of the Beacon Hill near Highclere in Hampshire, the line joining our two stations being approximately E.N.E. and W.S.W., and measuring some eighteen miles. There was a light air of force No. 1, from the N.N.E. Between 10 and 11 P. M. rocket charges were fired at each station, the moments of firing having been prearranged. The result was that the rockets were sighted (somewhat indistinctly, owing to haze), but not a suspicion of the distant sound was heard at either station, even with the aid of ear trumpets.

In view of this experiment, the next trial yielded results singularly remarkable and important. It was now announced in the London press that firing similar to that last described would take place during a given hour at night, but that the locality, as also the moments of firing, would be withheld as a test of the accuracy of observation. This enlisted the assistance of a great number of independent observers from different points, the accuracy of whose returns could be proved, and, moreover, through the courtesy of the commanding officers, I secured the valuable co-operation of practised observers in the two large military camps then lying at Bulford and Churn. The firing station was the Hants Beacon Hill, already spoken of, which is fairly midway between each of the above camps, and at about eighteen miles distant from each, with fine open country only intervening. The hour chosen was, as before, between 10 and 11 P. M., but the wind on this occasion was blowing stiffly, with a force of four or five, in a direction that was approximately at right angles to the line joining the two camps. The weather since the last trial had remained rainless and warm, and there was now less haze. On the other hand, it was noticed by the firing party that the sound of each explosion was much drowned by the noise of the wind, and the resulting echoes quickly lost. It was a night apparently most unfavorable for the travel of sound, except possibly down the wind, and it was not surprising that no records were received from Churn, or, with one exception, from any station distant more than ten miles. The one exception, however, supplied a most unlooked for and interesting result. A staff captain of Royal Artillery had, by direction of the commanding officer, stationed himself on the same Beacon Hill on Salisbury Plain which I had occupied at the former trial. This officer was wholly ignorant, as was everyone save the firer, of the number or times of the signals which would be fired, yet in course of post, I received a perfectly accurate and complete record of all the reports, not one of which had been missed by him. On the other hand, there were several cases where, to groups of observers within what should have been easy sound range, certain of the reports had been quite inaudible.

I was now in possession of fresh and special evidence as to the abnormal behavior of sounds of explosion for which atmospheric conditions could alone be responsible. Pursuing the inquiry, I next transferred my point of observation to the upper air, so arranging matters that I should be able to sail at different heights over the whole breadth of London and the open country beyond, both in day and also in night hours. My object here was to secure the independent records of a great number of observers; to test a variety of sound signals, as well as sound-receiving instruments; to determine where with reference to altitude and direction sounds traveling from above or below were best heard, and to make accurate records of air currents as well as of the physical condition of the upper levels through which I should travel.

My first ascent was from the grounds of Stamford Bridge, on the afternoon of the 13th of August, starting at 5 P. M., at which hour there was a gentle breeze from the southwest, growing somewhat stronger with increasing altitude. We rose rapidly, keeping a course at first almost in a direct line for the British Museum, when, having attained an altitude of about 2,000 feet, we came under the full influence of the sun, which became now unobscured by cloud, and thenceforward we ascended with but few fluctuations to a height of about 5,500 feet, by which time we were well out beyond the northeast suburbs, heading for Chelmsford. At the altitude just mentioned, and approximately over the Angel, the temperature had fallen nineteen degrees, and the air had grown moister with an accession of humidity that was settling earthward, and which declared itself in heavy wet throughout the following day. There were slight deviations in our course, once over Hackney, when our direction became somewhat more easterly, and again over Wanstead, where we returned to our former course. Eventually finding ourselves over sparsely inhabited country, we descended near Woodford Bridge, outside the grounds of Claybury Asylum.

As may be supposed, our experiments having been freely announced in the London press, we were closely watched by a vast number of observers in the town and out in the open country; and in due course a great number of observations were sent, to various papers and myself, which have since been carefully collected and compared. To avoid confusion, I had fired two guncotton charges only, the first of which was exploded almost immediately over Soho Square; the second four minutes later, at the moment when we crossed Gray's Inn Road, about half way along its length. I should here remark that as on all previous occasions no aerial echoes whatsoever were heard, only after due interval the bursts of thunder from the housetops beneath, which were superlatively grand, but died out more quickly than I have known them to do at the same elevation. The records sent me from observers who heard these reports are not a little remarkable. In the case of each explosion the number of such sound observations made across the wind largely exceed the number of those made up or down the wind. This fact was strikingly indicated by a map of London, on which pins had been stuck representing the positions of different observers. These pins were found mainly to lie across the map in two somewhat winding streams, passing through the points of explosion, but each in direction athwart the balloon's course.

In the next place the longer ranges over which the sounds penetrated were chiefly in directions lying to right and left of us, and sensibly at right angles to our course. Thus we were heard in the north as far as about Tufnell Park, three miles away, the upper parts of Holloway and Kentish Town. Again in the south as far as parts of Kensington, three miles distant, and on Clapham Common, over more than four miles. But, on the other hand, in directions ahead of us and in our wake, we seem not to have been heard at any considerable distance. Indeed, Oakley Road, Islington, one and a half miles to leeward of the point of the second explosion, marks the longest sound range recorded down the wind. Somewhat further in the same direction, namely, in Clapton Park, two independent observers who were watching the balloon heard no report whatsoever. But another remarkable fact, apparently clearly established, is that in certain quarters, and not by any means quiet or near quarters, the sound seems to have been borne down with an abnormal intensity. Thus, in the higher parts of Islington, people sitting indoors are sufficiently startled to run to their windows and out into the streets. In Upper Street, in the same locality, such consternation was caused in a naturalist's aviary that the birds could not be pacified for more than an hour afterward. Again, near Westminster Abbey, as also across the river in Lambeth, there seem to have been plots of ground where the waves of sound broke with a burst, it being very evident that the river had offered no sound barrier to observers on the far side.

One or two unique records should not be omitted. An observer watching the balloon from a quiet garden at Stoke Newington fails to hear either explosion, although both are plainly heard at a considerably greater range on Clapham Common. Another observer near the Portland Road Station sees and hears the first explosion, but does not detect the second. Another, no farther away than Grosvenor Street, hears our horn, but neither of the reports. A gentleman on the pavement outside Parkins & Gotto's hears the explosion "like a squib," a sufficiently curious record without the further statement that it "smelt like gunpowder." It is certainly worthy of notice that not one single record has reached me from the open and quiet retreats of the principal parks.

One general deduction may at once be made from the above results, viz., that, as in the case of the rocket firing on Beacon Hill, sounds emanating from the sky seem to have traveled more readily across the wind than either up or down the wind. And this, it should be noted, is in agreement with certain quantitative measurements made long ago by De la Roche.

Another trial was now embarked upon, which though in some respects a repetition of the last, would differ from it in some important particulars. My aim was now to traverse London and the country once again, but during those night hours when street traffic has subsided, and to sail at such a height as would make it possible to communicate with passengers below, and by means of such individual sounds as would reach me, either directly or by echo, possibly to learn something of the mode in which the sound waves from near and far points rose upward to the balloon. Further, there would be an opportunity of testing the ranges on the ground of different sounds emitted from the balloon. For obvious reasons the firing of startling explosions was not ventured on.

In this second experimental voyage, as in the first, I gathered a great number of reports from independent observers below, and had not merely to rely on personal impressions. The night chosen was the 15th of August, after a short spell of wind and wet had again given place to warmer and more settled weather. Since our previous voyage the wind had veered from S. W. to W. N. W., blowing a gentle breeze on the ground, but at a height of 1,000 feet its velocity was fully twenty miles an hour and direction sensibly N. W. The start was delayed until 3 A. M., as it was judged that at that hour the air would be more equable, the streets at their quietest, and moreover, as the night, though clear, was moonless, and the sea only seventy miles ahead, it was thought prudent to make sure of the return of sufficient daylight to enable us to effect a safe descent. On leaving the earth, due precautions were taken to keep the balloon sailing as evenly as possible at altitudes that should not exceed 1,000 feet, and it was found at these altitudes until the time of dawn the change in temperature and humidity, as compared with that on the ground, was inappreciable. As soon as the balloon was released and the irrepressible exclamations of the bystanders ceased, we found ourselves in an unusual silence. In daytime at low altitudes the air, if heed be given, is always full of vague sound, but it was not so now. Here and there well-defined sounds were heard; a footfall in some street below, a distant railway whistle or the like, and it was the extraordinary clearness of these sounds that marked the acoustical transparency of the atmosphere. This rendered all sounds apparently much nearer than they really were. The voices of the little crowd we had just quitted, even when left far in our wake, appeared as if coming from only a few yards away. But environment was clearly a chief factor in modifying the travel and intensity of sound. Streets whose length lay square to our course became, as we crossed over them, avenues for sound along which a voice came loudly over extended ranges. It was the same as we crossed the river, where (doubtless partly owing to reflection from the surface) the sound range of a hooter would seem to have no limit. It was the same with echo. A trumpet having its mouth constructed to confine its voice as far as possible in the direction of its axis was repeatedly blown in different directions. This, when pointed directly downward toward the surface of a reservoir or wide-open ground, such as Battersea Park, produced a loud, short echo. The echo, however, became markedly louder if the point below was an open court or walled inclosure. When the horn, no longer held perpendicularly, was directed over the town, the echo came back as a wail indefinitely prolonged.

When the many observations from all parts of the town of those who had been abroad in the quiet night had been gathered in, it became apparent that the voice, aided by a paraboloid megaphone, was heard approximately over a mile range, and actual speech over half that distance. A voice in the streets, however, having the earth as a background, manifestly possessed more power than a voice coming from a speaker in the car of a balloon, with only empty space above him. It could hardly be determined whether sounds were better heard athwart our course than in line with it. The trumpet already mentioned appears to have had no practical limit to its range, but was difficult to interpret or locate. It was taken by many for a motor-car horn in the streets. A policeman satisfied himself that he was listening to a child blowing a toy trumpet in Kennington Oval. The sound in direction of its axis, however, was so penetrating as to wake sleepers in their beds, and in these cases there was never any doubt about its coming from the skies. Incidentally I may mention that the specially formed megaphone I have described possessed in a strongly marked manner the advantage of being only distinctly heard in the actual direction in which it was pointed. A cyclist approaching us down a side street hears half a sentence with ease and certainty, but loses the rest when he has traveled nearer but out of the little area covered by the instrument. Conversely, when the paraboloid mouth was used as an ear, its power of locating sound, as I have often proved in darkness and fog at sea, is very apparent. A train passing beneath us would give an indefinite rumbling which filled the air, but seemed to come from nowhere in particular. With this simple instrument, however, the source of sound could be at once traced and verified by the faint trail of illumined steam below.

Two more acoustical phenomena claiming attention occurred before the night was spent. One was the fact that the hour of five rang out from a village church tower ahead of us with a surprising distinctness. This undoubtedly might appear a very well marked instance of sound up-wind being caused to slant upward. The other instance was that of ghostly voices in conversation breaking in upon us as though spoken only just outside the car. Their source, which must have been at least 1,000 feet away, was never located. This curious occurrence may probably be classed with those instances of strange stray rays of distant sound that may affect a single observer, or else may strike on patches of ground here and there over wide areas. All who are observant will have noticed chance sounds that will stray from far, not necessarily to be repeated. On an afternoon during last summer, while sitting on a quiet lawn, I caught the full strain of a band playing at a garden show two miles away in a valley the other side of abruptly rising ground. This appeared so remarkable that I continued listening throughout the afternoon, during all of which period the band played incessantly, but was never heard from my point of observation again. In this case some wayward wind-current may surely be considered the sufficient and probable cause.

We have abundant evidence that certain localities, from the nature of their environment, are peculiarly open to the hearing of a particular sound. I have made systematic inquiries of a large number of signalmen and others (the requirements of whose duty renders their observations of value), who are commonly abroad and at attention at stations between fifteen and twenty-five miles from Portsmouth at the time of the firing of the sunset gun at that town. Their statements carefully recorded go to show that the gun is often and well heard at Petersfield, and at several places eastward of that station following the course of the stream, also on higher ground at Elsted, where, with a favoring wind, the Aldershot gun is also heard. On the other hand, at the next and all following stations northward of Petersfield no one has been able to state that they have ever heard the report. The naval guns are heard at the majority of stations between Southampton and Whitchurch, but with a distinctness that would seem not chiefly dependent upon distance. They are, however, heard more plainly even at long range along the coast-line—at Southwick, near Brighton, actually shaking doors and windows. This is what might have been expected with only sea intervening, but the sound reaching inshore would in many cases have had to surmount considerable obstacles.

Certainly it is abundantly clear that sounds having the ground as background readily ascend, passing by short passage through such barriers as are to be met with in the lower strata of atmosphere. Their mode of reaching earth again may be somewhat harder to conceive, but we have seen how the sound waves of wind instruments may rise from a valley and be borne down again as by a down-draught over a neighboring hill. It is easy also to picture how, in the case of an observer in a balloon watching copious masses of visible cloud below rising and drifting, certain points and patches on the earth which catch the sunlight are here and there glimpsed, showing up unsuspected avenues transparent to light through what would otherwise have been deemed a general cloud barrier. Conceivably the same character exists in the case of acoustic cloud, and unexpected paths are opened out for sound which has reached the sky to reach down also to various spots with greater or less frequency, according to local circumstances.

As to the deadening of sound proceeding from any particular source by the intervention of masses of air of different densities and temperatures, in other words, of acoustic cloud, the following is instructive: A ring of quicklime was laid on open ground, the lime slaked with water, and as soon as action was brisk various feeble sources of sound, a watch, a metronome, etc., were placed one at a time for short intervals alternately within and outside the ring. The experiment was made on a dark night, and observers who stood back in different directions were unable to see the sounding instruments, but they were always able to determine by the great variation in sound whether it was outside or inside the ring of slaking lime. When, however, the instrument used was a faint reed the case was altered, and the observers were constantly at fault.

I would then here add as a conclusion to which this inquiry has consistently led, that signals made by sounds of explosion are not the most reliable. Their penetration is obviously often uncertain, while their duration being brief they may be missed by momentary inattention. The reed horn was the more efficient instrument as compared with guncotton cartridges over London. The siren would probably have been yet more efficient, as also doubtless a horn capable of producing two notes differing, say, by the interval of a third or fifth—a conclusion arrived at many years ago by experiments which have been unhappily too much lost sight of. Prof. Piazzi Smyth found by trial that a high note was generally more penetrating as a signal, but advised that such a note should not be used alone, assigning as one reason that individuals possess note deafness similar to color blindness, so that no one note could be trusted. Experiment went to prove that a sound varying between a high and a low note best arrested attention at long range.

And the same result has been arrived at in another way. The peculiar cry of the Alpine guide—which is in fact of that nature which Prof. Smyth advocates—has doubtless been taught by the exigencies of his situation, where his voice is required to carry across broad and deep ravines. Nature has taught the same lesson in the Australian wilds, where the characteristic "Cowi, cowi," appears essential to penetrate the deep woods.

Nor, indeed, need we look further for an example of the same kind than our own village lanes. The high-pitched voices of children are very far-reaching. Their shouting can be heard farther away in the sky than that of men, and in calling to their fellows they always employ a trick of the voice taught doubtless by experience. The child will summon her playmate from far away with a well-practised "*Sal-lu*," the first syllable, high-pitched and prolonged, giving place to the second syllable uttered abruptly in a yet higher note. And this mode of calling is universal.—John M. Bacon in The Nineteenth Century. Republished by permission of the Leonard Scott Publication Company.

[Continued from SUPPLEMENT, No. 1355, page 21714.]

NICARAGUA OR PANAMA.*

By PHILIPPE BUNAU-VARILLA, former Engineer-in-Chief of the Panama Canal.

CURVES.—To examine this very important subject of curvature, the most essential of all for safe navigation, we have not yet the definitive plan of the Isthmian Canal Commission for the Nicaragua Canal, but as this Commission has adopted in its essential lines the Nicaragua Canal Commission's project, and as curvature is commanded nearly absolutely by the natural disposition of the ground, one may take, as a fair approximation, the curvature of the Nicaragua Canal Commission's route as the one that will be more or less presented by the definitive project. Leaving aside the curves in harbors, or at the entrance of the locks, where the ships have a very reduced velocity, we find that the Panama route has 23 curves of a totalized length of 19.5 miles, and that the Nicaragua route has 82 curves of a totalized length of 53.5 miles.

It is not enough to state the number of curves; it is much more important to state their radii. All the curves of the Panama Canal are of 10,000 feet radius or more, with the exception of three, which have 8,200 feet radius. There are, on the contrary, 69 curves in the Nicaragua Canal below 8,000 feet, of which 50 are between 3,000 and 4,000 feet radius.

But it is not only the number of curves and their radii which has to be considered, but also whether they are located in places where water will be still or not.

In Panama there are only three curves of 10,000 feet radius where the canal and the Chagres will be in the same location, that is to say, where eventually currents may take place. In Nicaragua we find 58 curves, having a total extension of 37 miles, where the canal will be located in the San Juan River itself, and of those 58 curves 43 are between 3,000 and 4,000 feet radius, and have a total extension of 26 miles.

It must be borne in mind, that in that part of the canal there will be nearly 28 miles excavated into the bottom of the river to a depth of 16 feet for the larger part. The maintenance of that channel opened into silt and sand seems (from my personal point of view) to be extremely difficult, and will necessitate constant dredging in a river carrying in floods 100,000 cubic feet of water, that is to say, one quarter of the amount in the Niagara Falls.

It is obvious that ships will meet there an accumulation of extreme difficulties, sharp curves, heavy river currents, constant heavy gales and impediments either from the dredges themselves, or from the sand and silt they will have to remove.

Who could guarantee that those combined difficulties when brought to the extremes simultaneously would not stop sometimes, even if not often, all transit?

In Panama, the large and easy curves, the absence of winds, the scarcity of river currents, and the rarity of floods, give quite a reverse impression as to the eventual facilities offered to ships.

Harbors.—With regard to harbors, the advantage, as every one admits, is with Panama, both of whose terminals have excellent harbors. The Nicaragua Atlantic terminal is very bad. The immense quantity of sand thrown into the sea by the San Juan, whose mouth lies south of Greytown, is maintained in suspension by the continuous agitation due to the constant easterly trade winds, and brought into Greytown by a continuous northern stream of sand. The Greytown harbor, which, fifty years ago, was a good one, is now virtually closed by the constant accretion of the sand, and the maintenance of the entrance to the canal there would be very difficult.

If it is understood by the designation of harbors, those points of the route where canal navigation is changed for a navigation into an immense body of water beaten by storms, and liable to give great waves, one is entitled to say that the Nicaragua route, outside of its ocean harbors, has two others in the Lake of Nicaragua.

This lake is a real sea, about as large as the Sea of Marmara.

The violent gales that continually blow over it, with sudden changes of direction due to the reflection of the currents of air on the mountains, make this interior sea always agitated. Its violent storms are quite characteristic and well known.

An inferior current brings to the southeastern side all the light sediment thrown into the lake by its tributaries, and this sediment accumulates in the region where the outlet of the lake, the San Juan, is located.

An artificial channel twenty-two miles long has to be dug in that mass of mud, and this channel forms, so to say, the harbor approach on the east side of the interior sea. Close to the point where this channel leaves the shore, a great torrential tributary of the lake, carrying a considerable mass of sediment, brought from the volcanic ridge of Costa Rica, falls into the lake: it is the Rio Frio, which will not add to the facility of maintaining the channel depth.

To judge at the same time the extraordinary difficulty of that maintenance and the danger to which transiting ships will be exposed in that harbor approach, one must forget the name of lake, which conveys the erroneous idea of still, sleeping water, and think what an unprecedented enterprise it would be to make a harbor approach in the ocean consisting of an artificial channel, twenty-two miles long, opened into mud or silt, and constantly exposed to be brutally filled up by the sweeping waves at every storm.

Such a point of view would be in the actual case much nearer to reality than the conception of a channel opened into the bottom of a Swiss lake.

Building Expenses and Time of Transit.—The exceptional advantages which characterize the Panama route compared to the Nicaragua route are in no way counterbalanced by larger building expenses. According to the estimates of the Isthmian Canal Commission, the completion of the Panama Canal will cost $58,000,000 less than the construction of the Nicaragua route, which is estimated at $200,000,000. It is obvious that the estimation of the cost of completing such a work, where already 77,000,000 cubic yards have been excavated, in all parts of the Isthmus and in all conditions of work, enjoys a far higher degree of certainty than an estimate made on a line where no works have been executed*: on the other hand, it is a matter of common experience that whatever be the care with which surveys, soundings and plans are made, the unforeseen circumstances which are met in a new ground do not modify the provisions toward reduction of expenses, but toward increase.

The time of transit is estimated by the Isthmian Canal Commission at twelve hours for Panama and thirty-three for Nicaragua. If one remembers the length of the two routes, and the number of locks, it is evident that this calculation must have been based upon the hypothesis that ships will go at the same speed in both cases, and that no allowance was made for the difficulties to be met on the Nicaragua route.

This shows that the advantage of distance over Nicaragua, between both sides of North America, is practically erased by time of transit.

PART II.

Stability.—I propose now to touch upon another point which does not concern the construction proper of the canal, but has reference to future contingencies, and which was not discussed by the United States Isthmian Canal Commission in its preliminary report.

I wish to speak of a danger arising from seismic disturbances, both during construction and after.

In Panama, there is within a distance of one hundred and eighty miles from the canal no volcano, even extinct. The Isthmus there, since its formation in the early quaternary period, before man appeared on the earth, has not been modified.

This is quite the contrary in Nicaragua, which has been always the site of seismic convulsions, whose lake was formerly a gulf of the Pacific Ocean, and whose name was associated with the most terrible volcanic explosion ever recorded in history before the Krakatoa explosion in the Sunda Islands.

The explosion of the volcano Coseguina in 1835 lasted 44 hours, the noise was heard at a distance of 1,000 miles, the ashes were brought 1,400 sea miles by the winds, the mass ejected into the air was calculated to have covered a surface equivalent to eight times the surface of France, and the volume was calculated to be equal to 50 cubes having sides of 1,100 yards, which allows me to say that during these 44 hours the volcano *ejected every six minutes a volume* of stone and ashes *equal to the total volume of the prism of the Nicaragua Canal*, as it was calculated by the Nicaragua Canal Commission, and which will necessitate eight years of excavation.

In the very center of Lake Nicaragua is a volcano in constant activity, the Omotepe, whose last great eruption occurred in 1883.

Between the two above named volcanoes we find a series of volcanoes in recent or continuous activity, the Hell of Masaya, on the shore of Lake Nicaragua, the celebrated Momotombo, on the shore of Lake Managua, the volcano of the Pilas, which was born in 1850, the Santa Clara, the Zelica, the Nindiri, being the best known of them.

The continuity of volcanic disturbances is stated in an appendix to the Nicaragua Canal Commission's report: "In the northwestern part of Nicaragua slight earthquakes are frequent. *Scarcely a month passes without one or more being noticed.* The center of these disturbances is always near the line of the Nicaragua volcanoes; *the line of volcanoes begins with Madeira* (near the Omotepe), at the southern end, in Lake Nicaragua, and terminates at Coseguina, at the northern end, near the Gulf of Fonseca."

Two most important facts have been recently established by Mr. Bertrand, foremost geologist and member of the Institute of France.

(1) *The Lake Nicaragua is one of the three lines of least resistance in Central America, which are a site of election for great seismic disturbances.* It is the line of depression between the Costa Rican volcanoes and the Nicaraguan, and plays the same part as the other two: the Bay of Fonseca, which is a volcanic lake characterizing the depression between the Nicaraguan and Salvadorian volcanoes, and the Lake Pacayan, characterizing the depression between the Salvadorian and Guatemalan volcanoes. These two last lines of least resistance have been the site of the most terrible convulsions owed to the Coseguina for the former, and to the Fuego (Fire) for the latter.

(2) *The underground fire is going south, and increasing in Nicaragua.* From the figures given by Mr. Bertrand I calculated that before the nineteenth century, out of all the great explosions of earthquakes recorded, 45 per cent belonged to Guatemala, 35 per cent to Salvador, and 20 per cent to Nicaragua, whereas, in the nineteenth century, only 30 per cent belonged to Guatemala, 45 per cent to Salvador, and 25 per cent to Nicaragua, showing an evident tendency to a displacement of the activity southward and an increase in Nicaragua.

To justify these figures one can say that several volcanoes became extinct in Guatemala, and that none was extinct in Salvador nor in Nicaragua, but, on the contrary, that two were born in Salvador, Izalco, in 1770, and Ilopango, in 1880, and one was born in Nicaragua, that of Las Pilas, in 1850.

Danger for Construction.—The continual earthquakes may have a fatal influence on the definitive transformation from half-liquid mud into hard stone, of the concrete, which will during eight years be continually poured in the great Boca San Carlos dam; these violent shocks, interfering every month or more with the gradual crystallization of the elements of concrete, may destroy their reciprocal adherence, and ruin the perfect homogeneity of the solid mass which is imperatively necessary for the part it has to play.

Danger for the Canal Once Built.—It is entirely false to compare the equilibrium of dams and locks with that of a high tower of a church. A wall or tower even fissurated can stand after an earthquake. A longitudinal fissure in a dam, which will not alter its equilibrium as a wall without pressure of water, would mean its immediate overthrow when the water pressure is exerting its force upon the surface of the inside fissure.

Outside of the impending and terrible danger of seeing ruined the dam or the locks by a great seismic commotion, one must not forget that there is great probability of seeing formed in the sea of Nicaragua, which is 100 miles long and 45 miles wide, one of those terrible tidal waves which were so destructive in Lisbon (earthquake of 1752), and Krakatoa, 1883, the latter being 100 feet high and the former 40, and which caused unlimited disaster.

It must be borne in mind that these terrible menaces would mean, if realized, not only the destruction of that costly canal, but the ruin of the immense interests of both sides of America, which will have been developed by the great waterway and receive a death blow by its paralyzation.

Transformation of the Panama Canal into a Bosphorus.—Nothing similar can be feared in Panama, as no trace of any local volcanic activity may be found on that Isthmus, whose rare and small seismic vibrations come from distant centers.

The future, on the contrary, far from being open for destruction, is open for a gradual transformation from a lock canal into a level canal, into a Bosphorus, which means a rapid transit in five hours from ocean to ocean. This can be done without stopping or troubling the navigation, even for a quarter of an hour, by following the solution I have given years ago to this question, which is extremely simple, and consists, all engineers will understand me, in making the two gates of a lock of the same height.

CONCLUSION.

The facts I have related demonstrate the following statements:

I. It is very questionable whether the continuous earthquakes will allow the construction, on the Nicaragua route, with all its indispensable qualities, of a

* Address to the Chamber of Commerce of the City of New York.

* The Isthmian Canal Commission states that the only excavation executed on the Nicaragua Isthmus consists of a channel between 150 and 230 feet wide, 16 feet deep and three-quarters of a mile long. This insignificant work made in the Greytown swamps represents a cube inferior to one three-hundredth part of the total volume of the prism of the Nicaragua Canal.

substantial masonry dam, which is the key of the whole canal.

II. Admitting a dam could be built, the Nicaragua route, whatever may be the engineering skill displayed and the expenses made, will *never acquire* the two most essential qualities necessary to an interoceanic canal—*continuity of operation* and *security of transit*.

The large ocean steamers will have there to struggle, deprived of any means of resistance,* against the combined efforts of the continuous violent gales, of the heavy river currents, of the impediments resulting, of the constant modifications of the depths in the channel, and of the presence of the numerous dredges that will have to keep the way open, and this when they will be steering with great difficulty around an extraordinary number of curves, the short radii of which ought to be, in themselves, considered as incompatible with the navigation of big ocean ships in a narrow channel.

The ships will also have to meet two bad, exposed, and dangerous passages when going from the Atlantic into the canal and from the canal into the Lake of Nicaragua.

One is allowed to say that *continuity of transit* and *safety of navigation will be constantly at the mercy of conflicting elements and beyond the control and provision of man.*

III. If the experience of four centuries is not a mere word, if the undisputable proofs, written in letters of fire on the surface of the soil,† of the continuous violent and increasing volcanic activity in Nicaragua, are not a mere dream, the route over that Isthmus is not only eventually exposed to, but certain, sooner or later, to be the prey of that uncontrollable power of nature before which flight is the only resource.

If one thinks that not only the enormous cost of such a waterway would be at stake, but also the very basis of the prosperity, the wealth of the millions of people who will settle on the west coast of North America, as soon as the construction of the canal will join them with the other side of the continent and with Europe, one hesitates to calculate the consequences that would result from one of these seismic convulsions, which most probably will be still more terrible in the future than they have been in the past on that part of the Isthmus.

To prefer definitively the Nicaragua route to the Panama route, the unstable route to the stable one, would mean to prefer the stability of a pyramid on its point to the stability of a pyramid on its base when to that stability is attached the prosperity and welfare of a whole continent.

IV. The Panama route, having no winds, no currents (except on rare occasions), no sharp curves, no sediments, no bad harbors, no volcanoes, enjoys to the highest degree the three essential qualities totally wanting for the Nicaragua solution—*continuity of operation, security of transit, stability of structure.*‡ Outside of that it is three times shorter, will cost much less than the Nicaragua route and is easily transformable into a Bosphorus, the only form that will definitely answer to the world-wide interests to be served by the route, and allow of a passage from ocean to ocean in five hours.

THE ALCOHOL MOTOR.

FOR some time past the French public has been studying a new question—a question interesting from the standpoint of the engineer, important from an economical point of view, and, above all, eminently French: the question of alcohol in its domestic and industrial applications. Among the latter the utilization of this combustible in explosive motors is the most interesting, and this is why the experiment has been tried of, substituting for imported gasoline a national product resulting from our French or colonial crops. One of the unquestioned advantages of alcohol over gasoline is that alcohol is a fixed product, whatever may be its use, and no one ignores the fact that alcohol can be abstracted, after fermentation, from a great number of plants and sweet or feculent products, such as beet roots, sugar cane, sugar molasses, wines, skins of raisins or of fruits, potatoes, rice, maize, sorghum, manioc, waste brewery products, yeast, roots, lees and the like. The same alcohol for motive purposes can therefore be produced in any part of the globe, and its origin is revealed only by special aromas, which are of no consequence when it is used as a motive force.

Under these conditions the first question that suggests itself is, on the use of alcohol: "Is it advantageous?" If the consumption of alcohol motors is compared with that of gasoline it is seen at once that the former consume considerably more than the latter; and as the alcohol is the more costly of the two combustibles, the problem would seem *à priori* insoluble from an economic point of view. But this is not, however, all of it.

Since denatured alcohol only contains 5,100 calories per kilogramme, while gasoline contains 11,400, it has been found necessary to raise the calorific power of the former and at the same time lower its price, and so it has been mixed with rectified benzine, which contains 9,200 calories per kilogramme, and which can be produced under good conditions at a low net cost. Mixtures containing from 50 per cent to 75 per cent of alcohol have been used; but it is the 50 per cent mixture which has a calorific power of 7,145 calories, that seems to be the most advantageous at the present state of development. From the result of numerous trials made in France it has been found that the consumption of 50 per cent carbureted alcohol is nearly the same as that of gasoline for a given power, and this notwithstanding the difference in the theoretical calorific powers of the two combustibles, from which it follows that the efficiency of the alcohol motor is greater than that of the gasoline.

Some very exact experiments made by Prof. Musil at Berlin have shown the efficiency of various kinds of motors to be as follows: Motors run on city gas (according to the type), 18 to 31 per cent; portable steam motors, 13; kerosene motors, 13; gasoline motors, 16; alcohol motors (mean figure), 23.8 per cent.

The high efficiency is evidently due to the great elasticity derived from the expansion of the water vapor that is contained or produced in the alcohol at the moment of its combustion, this expansion tending to make the explosions in the cylinders less violent than when gasoline is used, and thus giving a longer life to the wearing parts of the motor. So much has this been found to be the case that in order to increase the beneficial action of the water vapor the German Motor Construction Company, of Marienfeld, recommends a mixture containing 20 per cent of water, and it has built motors to run on such a mixture that consume only 0.375 kilogramme per horse power hour. The fact must not be overlooked, to be sure, that in order to secure good efficiency with either pure or carbureted alcohol recourse must be had to specially constructed motors having the following characteristics: The stroke nearly double the bore, high compression and a good spark.

Finally, the result of the latest experiments recently made in France on the "Economic" motor, which was specially constructed for use with alcohol, has been a lowering of the consumption to 0.272 kilogramme per horse power hour for medium-sized motors, employing a 50 per cent mixture of carbureted alcohol. For stationary motors the problem is therefore solved.

When it has to do with automobiles the substitution of alcohol carbureted with gasoline is a matter of great interest, for it is evident from statistics that if a liquid containing 50 per cent denatured alcohol could be used day in and day out in the mechanical vehicles the production of the French distilleries would be doubled immediately.

There is no doubt whatever that if the purchasers of automobiles required of the manufacturers carriages that would work equally well on 50 per cent carbureted alcohol or gasoline the manufacturers would devise practical and simple apparatus, so that one combustible could be immediately substituted for the other; and that supply stations having carbureted alcohol would soon be established throughout France just as gasoline supply stations were established.

A little perseverance and attention is all that is necessary, therefore, to make the alcohol motor prosper in France, as has already been done two years ago in Germany, by the efforts of the two institutions created for this purpose, one technical—the Institute of Fermentations, of Berlin—and the other commercial—the Central Syndicate for the Introduction of Alcohol.

The Minister of Agriculture has so thoroughly comprehended the interests of the first order involved in this question that he has organized an official trial of apparatus using alcohol for lighting, heating, and stationary, automobile, and boat motors.—La Nature.

15-HUNDREDWEIGHT STEAM HAMMER.

WE illustrate a very conveniently arranged steam hammer exhibited at the late Glasgow Exhibition by Mr. John Cochrane, of Barrhead, near Glasgow. The piston head and rod are forged in one piece, and weigh 15 hundredweight. As shown, the rod has flats planed along its whole length, and the bushes and glands of the stuffing-box being shaped to fit, no further guidance of the rod is necessary, as it is impossible for the hammer to twist round. The hammer head is of cast steel, and is secured to the rod by a dovetail and key as shown. The anvil block has a cast-steel face secured in a somewhat similar manner. The cylinder is 16 inches in diameter by 36 inches stroke. As shown, the steam ports are grouped near the top of the cylinder. The steam is distributed by means of a piston valve working in a valve chest bolted to the cylinder. This chest is bushed with gun-metal. The stop-valve is fixed near the upper portion of the steam chest, but the handle operating is carried down within easy reach of the hammerman. A self-acting gear is provided, which, however, can be thrown out of use in a few minutes when desired. The total weight of the tool is 10½ tons, and it occupies a floor space of 11 feet by 4 feet 10 inches.—We are indebted to London Engineering for the engraving and description.

Fig. 1.

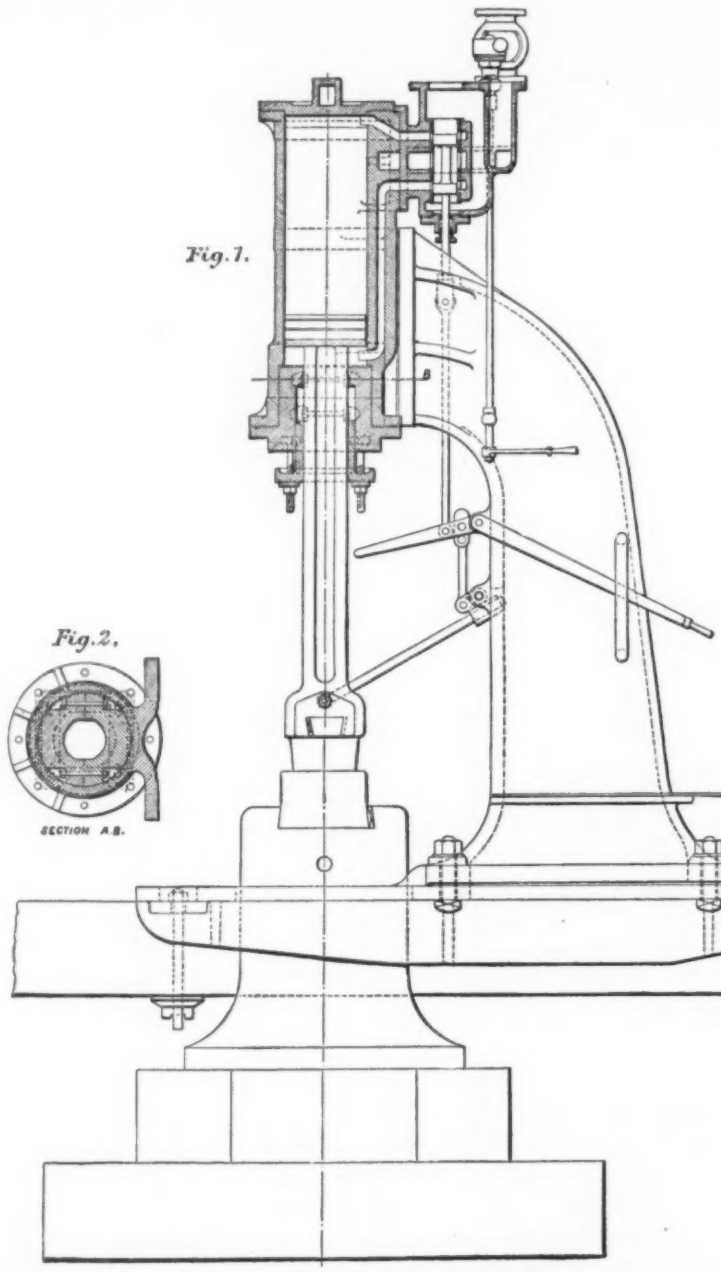


Fig. 2.

15-HUNDREDWEIGHT STEAM HAMMER.

* It is a fact well known to naval men, that a big ship floating in shallow water is partially deprived of its steering faculty. The reaction of inferior currents on the rudder disables it to a certain extent, and its action is uncertain and irregular.

The accident suffered by the battleship "Massachusetts," that got aground going out of Pensacola on the 21st of March, when this pamphlet was in course of printing, is a good illustration of this disability of steering in shallow water.

† To the people who think I am exaggerating this capital point I will say: Open any dictionary of geography, any encyclopedia, and read the article titled "Nicaragua." I will say also: look at the coat of arms of the Republic of Nicaragua, look at the Nicaraguan postage stamps. Young nations like to put on their coats of arms what best symbolizes their moral domain or characterizes their soil. What have the Nicaraguans chosen to characterize their country on their coat of arms, on their postage stamps? Volcanoes!

‡ The superior qualities of the Panama route, from the point of view of safe and continuous operation, are such that it can be fairly asserted that, assuming the two canals were built and that of Nicaragua freed of any tolls, ships would, in the intermittent periods of navigability of the Nicaragua Canal, still prefer the Panama route, as the tolls of this canal would certainly be less than the insurance fees to be paid to pass over the unsafe route of Nicaragua.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Trans-Caucasian Petroleum Pipe Line.—Vice-Consul-General Murphy sends from Frankfort, October 24, 1901, the following translation from the Frankfurter Zeitung:

The principal sources of supply for the world's petroleum market (in which, as is well known, Germany is one of the principal buyers) are the United States and Russia. In all probability, there will be no change in this respect in the near future, as the other petroleum-producing countries do not supply enough for their own use. The beginning of the work of laying pipes from the petroleum district of Baku to the port of Batum promises, however, a change in the relative competitive strength of the United States and Russia.

In the year 1900, Russia supplied 35 per cent of all the petroleum offered for sale in the markets of the world—namely, 73,000,000 poods* (365,000,000 gallons) out of a total of 207,000,000 poods (1,035,000,000 gallons). In 1900, Russia produced 672,000,000 poods (3,360,000,000 gallons) of naphtha, while the production of the United States was only 421,000,000 poods (2,105,000,000 gallons). The weak participation of Russia in supplying the world's markets was due to the fact that Russian freight rates to the seaport are too high and the means of transportation are inefficient. The reason usually given in Russia—namely, that the producers, for business reasons, give more attention to the manufacture of naphtha products than to the refining of oil—is correct only because of the obstacles to transportation just mentioned. The transportation of Russian petroleum is now effected by means of the Baku-Batum Railway and the railway from Petrovsk (on the Caspian Sea) to Novorossisk (on the Black Sea). The latter is of minor importance, and carries petroleum only when the Baku-Batum line is overburdened with traffic or when the prices of petroleum are so high that this more expensive route can be profitably used. The Baku-Batum line is 842 versts (558.2 miles) long, and has a double track for only two short stretches of 151 and 94 versts (100.1 and 62.3 miles). With its present supply of tank cars—about 1,600 large ones, each holding about 750 poods (3,750 gallons), and about 3,400 small ones, with a capacity of 610 poods (3,050 gallons)—the railway is capable of transporting to Batum, allowing thirteen days for the round trip, about 80,000,000 poods (400,000,000 gallons) per annum, though as yet the amount has seldom exceeded 60,000,000 poods (300,000,000 gallons), owing to the frequency of railway accidents. Since October, 1900, a pipe system 215 versts (142.5 miles) in length has been in operation between Michailovo and Batum, but, owing to careless management, only about 3,800,000 poods (19,000,000 gallons) per month has so far been forwarded in this way. By the end of 1902, another 134 versts (88.8 miles) of pipe line will have been laid. An imperial order was issued in July of this year for the completion of the remainder of the line—469 versts (310.9 miles). From Baku to Voltschi-Vorota—11 versts (7.2 miles)— a pipe line has long been in use. The completed system will have a capacity of 125,000,000 poods (625,000,000 gallons) per annum. The transmission of each pood (5 gallons) of petroleum through the pipe will cost the State 1.2 kopecks (0.6 cent), the net cost of forwarding a pood by rail being 3.9 kopecks (2 cents).

As the Russian government has undertaken the completion of a pipe line not merely as a financial venture, but for the declared purpose of helping the Russian petroleum industry to compete in the markets of the world, it will probably be satisfied with moderate profits, in order to accomplish its object. By ministerial decree of February 15, 1900, the railway freight rate per pood was raised from 10 to 16 kopecks (5 to 8 cents), the price having once been as high as 19 kopecks (9 cents). After the pipe line is completed at the end of 1903, rates will probably be much lower than ever before.

Thus, the Russian petroleum industry will be enabled to compete with the American industry in the markets of the world, if other conditions remain favorable, especially if no change be made in existing commercial treaties and in the rates of duty fixed thereby. Moreover, Germany can, by assuming a friendly or a hostile attitude toward Russian petroleum and naphtha products, enforce its wishes in negotiating a new commercial treaty with Russia. The Trans-Caucasian petroleum pipe line will force Russia into the world's markets as a seller.

American Exhibition in England.—Consul-General Osborne transmits from London, October 30, 1901, prospectus of an American exhibition to be held at the Crystal Palace, Sydenham, from May to September, 1902.

This exhibition, he says, is well backed, and has an influential American advisory committee.

The Crystal Palace is a very large building, and practically the whole of the interior space will be devoted to the exhibition. It should prove of benefit, commercially and socially, to both countries.

The prospectus reads:

The American exhibition, 1902, is designed to demonstrate the immense commercial development which has taken place in the United States during recent years, and will be the largest and most important exposition of American products, arts, industries, and inventions yet seen in the United Kingdom.

The increase of exports for the past twenty years has been phenomenal, and the expansion in the character and variety of the trade is perhaps even more remarkable than the increase in its volume.

With a population of over 80,000,000, and a climate ranging from Arctic Alaska to the tropical South—with their vast natural resources, and their great industrial wealth and activity—the United States offer a wider scope than any other individual country for a great national exhibition.

The natural advantages of the Crystal Palace for the accommodation of great exhibitions are well known. The buildings cover about 16 acres, are perfectly lighted, heated, and ventilated, surrounded by the most beautiful ornamental grounds in Europe, extending over 200 acres, and including the most extensive series of sports grounds in England for cricket, polo, football, baseball, cycle and motor racing, tennis, swimming, and other athletic sports.

The regular programme of entertainments, music and sports, is—like the annual attendance of visitors—upon a greater scale than anywhere else in the United Kingdom.

The jubilee of the first great International Exhibition, 1851, held in the Crystal Palace, has been celebrated this year by a naval and military exhibition, opened on May 23 by Field-Marshal Earl Roberts, K. G., which has been attended by the largest number of visitors during recent years.

The year 1902 will be marked by an historical event—the Coronation of King Edward VII. in the month of June—which will draw to London the greatest number of visitors from the provinces and abroad ever before known.

In the popular rejoicings and festivities which will take place throughout the Empire, the Crystal Palace, as the greatest national center of entertainment, will take the lead. No more auspicious time and place, therefore, could have been selected for a great exhibition, and it is felt that the directors have exercised a wise discretion in arranging for one devoted exclusively to the United States. From the support already forthcoming, a complete success is assured.

During the period of the exhibition, a number of the best American entertainments and shows will be introduced in addition to the regular programme of attractions at the Crystal Palace. It is intended also to engage one or more of the leading American bands.

The exhibition is certified by the Board of Trade under the provisions of the patents, designs, and trade-marks act, 1883.

In connection with the exhibition it is proposed to establish, under the direction of a committee of representative American and British firms, a commercial bureau, so that all necessary information may be supplied to exhibitors with regard to channels of trade and the placing of goods upon the British and continental markets.

For the convenience of exhibitors, arrangements will be made with a well-known firm for the supply of approved stands or cases for exhibits, either to order or on hire, at moderate rates, but exhibitors are at liberty to make their own arrangements in this respect.

Plans and particulars of space—the charges for which range from 4s. to 20s. (97 cents to $4.86) per square foot, according to position—will be forwarded on application to the Assistant Commissioner for Commercial Section, 20 Victoria Street, London, S. W., or to the General Manager, Crystal Palace, S. E.

CLASSIFICATION OF EXHIBITS.

Class I.—Machinery and mechanical industry; (*a*) Mining, agricultural, printing, electrical, traction, haulage, etc.; (*b*) shipbuilding, locomotives, railway and tramway engineering and equipment; (*c*) automobiles, bicycles, typewriters, sewing machines, laundry, domestic and other labor-saving appliances, etc.; (*d*) hardware, tools and cutlery.

Class II.—Natural and agricultural products, including cotton, timber, mineral ores, wool, tobacco, etc.

Class III.—Prepared food products, including canned and other goods, condiments, confectionery.

Class IV.—Pharmaceutical and kindred preparations, surgical appliances, drugs, perfumery, etc.

Class V.—Carriages, vehicles, harness, furniture, leather goods, stationery, etc.

Class VI.—Hygiene, lighting, heating, ventilating, and sanitary appliances.

Class VII.—Textiles, fabrics, clothing.

Class VIII.—Musical instruments, photographic and optical apparatus and material.

Class IX.—Education and science.

Class X.—Naval and military, ordnance, ammunition, small arms.

Class XI.—Arts, painting, sculpture, engraving, lithography, architecture, and decoration.

Class XII.—Woman's section.

The rules governing the exhibition, with form of application and plans of the Crystal Palace, have been filed for reference in the Bureau of Foreign Commerce.

Municipal Kitchens in Nantes.—The city of Nantes has an inexpensive method for supplying food to the destitute, as well as providing them with lodging for the night. For several years, the city has managed a system of municipal kitchens, known as "Les Fourneaux Alimentaires Municipeaux," where persons without money may present tickets and procure a warm, substantial meal. The city has also recently erected one of these buildings, having in connection therewith a dormitory, with beds for the accommodation of about fifty persons. These beds are free to the destitute for a period of three nights, when they are obliged to make room for others. The sick are sent to the hospital. During the stay at the dormitory, each one is given two meal tickets each day. These municipal kitchens are open from the 15th of October until the 15th of April each year, but the dormitory is open during the entire year. Two meals are served each day, the noon meal from 10.30 A. M. until 1.30 P. M., and the evening meal from 5 until 7.30 P. M. With the exception of the kitchen connected with the dormitory, the meals are not exactly free, but the prices are so low that no one is obliged to suffer from hunger. Tickets entitling the holder to one dish of anything on the bill of fare are deposited at the bakeries and tobacco shops throughout the city, where they are purchased by the charitably inclined citizens, who in turn hand them to the applicants for charity.

The following is the bill of fare furnished daily, together with the prices: Beef soup, boiled beef, beef stew, beef with sauce, codfish, pork and cabbage, beef à la ravigote, stewed tripe, eggs à la tripe—each plate 2 cents. Water soup, beans, and rice are furnished at 1 cent per plate. When these kitchens were first opened, the expense to the city was considerable, but during recent years the deficit has been gradually reduced until last year it was only 8,000 francs ($1,544). The total expenses for the same period were 48,000 francs ($9,264) and the receipts 40,000 francs ($7,720). There is a superintendent over all the establishments, who receives a salary of 250 francs ($48.25) per month. In each kitchen there is a director at 60 francs ($11.58) per month, a cook at 45 francs ($8.68), and an assistant cook at 40 francs ($7.72), all being women. This does not include wages paid in the dormitory.

The following indicates the kind and quantities of food consumed druing the past year in the eight kitchens.

	Pounds.
Beans	33,000
Rice	1,540
Salt	9,020
Sugar	440
Pepper	264
Potatoes	110,000
Carrots	8,800
Turnips	8,800
Cabbage	13,200
Leeks	4,400
Onions	5,500
Milk	5,500
Garlic	330
Meat:	
Beef	17,600
Bacon	2,640

The amount expended for fuel was $1,061 for coal and $96.50 for wood.

The privilege of taking meals in these kitchens is not restricted to the destitute class. Many of the laboring men obtain their meals there on account of the moderate prices. A moderately substantial meal may be obtained for 5 cents. For example, the meal may consist of a plate of meat, a bowl of soup, and a small loaf of bread. Wine is not served at any of the kitchens.—Joseph I. Brittain, Consul at Nantes.

Eggs in Belgium.—Under date of Brussels, November 8, 1901, Consul Roosevelt transmits the following:

In view of the fact that Belgium annually imports large quantities of eggs from various European countries to meet the demand of home consumption, I transmit the following report, which may interest egg dealers in our country desiring to extend their business, as Belgium is a good market for fresh eggs and pure butter. Prior to the past two or three years, Italy enjoyed almost a monopoly in furnishing Belgium with eggs. Since 1899 Bulgaria has been Italy's most important competitor in this special exportation, and in that year shipped 3,100,000 kilogrammes (6,820,000 pounds)—in Bulgaria eggs are sold by weight—representing a value of $328,100; and last year the quantity exported amounted to 4,500,000 kilogrammes (9,900,000 pounds), valued at $463,200. Since January, 1901, the exportation of eggs from Bulgaria has tripled.

American Locomotives in France.—A great deal of interest has been manifested in this portion of France in the experiments of the Paris, Lyons, and Mediterranean Railway Company—the most important railway corporation in this country—in importing a number of American locomotives. The first delivery was made in this city in March, since which time the locomotives have been in process of erection in the company's shops at Arles. I have been informed by one of the officers of the company that after these machines had been erected, the controlling forces of the roadmaster's department objected to their use, because of the fact that the weight was unevenly distributed over the various sets of wheels. It was thereupon concluded to make such changes in the mechanism as would evenly distribute the weight to the satisfaction of the roadmasters. This has now been done, and the machines are in partial commission. While they are thus, indeed, American locomotives, it does not appear that they are absolutely of the type commonly manufactured in the United States. My informant tells me that in preliminary runs, these locomotives maintained a speed of 71.45 miles per hour.

A local newspaper of to-day supplies these additional details:

Yesterday morning for the first time the rapid express No. 7 was conveyed from Avignon to Marseilles by one of the new American locomotives erected at Arles. This machine, No. 2,999, was attached to a train of four large cars of the first class, weighing 34 tons, and two baggage cars, the total weight being 181 tons. The mining engineers charged with the control of this matter have been making recently, in connection with other principal agents of the company, numerous experiments with these machines between Miramas and Arles. The rates of speed attained have exceeded at certain moments 77.67 and 80.77 miles per hour upon this portion of the track, which, by reason of its favorable condition, lends itself better than any other to these interesting and important experiments, the results of which, from the point of view of regularity of speed and general stability of these new engines, have been most satisfactory.—Robert P. Skinner, Consul-General at Marseilles.

* 1 pood = 5 gallons.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1209. December 9.—Need of Direct Steamship Service to Africa.

No. 1210. December 10.—Mineral Wealth of British India—Fruits and Vegetables of St. Christopher—*Eggs in Belgium.

No. 1211. December 11.—*Competition for Military Tractor in Great Britain—Cotton and Flour Mills in Sao Paulo—*Exposition at Tetschen, Bohemia—*Trade School at Solingen—*Coal in Spitzbergen.

No. 1212. December 12.—*Artificial Fuel in Belgium—Baggage of Passengers for Japan—Industrial Depression in Austria-Hungary—Industrial Undertakings in Hungary.

No. 1213. December 13.—Railroads in Russia—New Mexican Cable—Communication with Cyprus—American Goods for Australia—American Tin Plate for Syria.

No. 1214. December 14.—Utilizing Beet Residue and Sawdust—*Opening for American Machinery in Bohemia—Tangential Traction—*Quinine Auction at Batavia—Sulphate of Copper for Greece—Sugar in Austria-Hungary in 1901.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

To Paste Celluloid on Wood, Tin or Leather.—To attach celluloid to wood, tin or leather, a mixture of 1 part of shellac, 1 part of spirit of camphor, 3 to 4 parts of alcohol and spirit of camphor (90 deg.) is well adapted, in which 1 part of camphor is dissolved without heating in 7 parts of spirit of wine of 0.832 specific gravity, adding 2 parts of water.—Die Werkstatt.

Improved Finnish Coating.—A very cheap but perfectly weatherproof coating is recommended by Edm. Campe in the Bautechnische Zeitung. Take 1.5 kilogrammes of wheat flour No. 2, dissolve it with a little cold water into a sirupy consistency and pour this slowly into about 22 to 23 liters of boiling water; add 0.5 kilogramme of crystallized zinc vitriol, and after this is dissolved, add for an oak shade 4 kilogrammes of elutriated yellow ocher and ½ to 1 kilogramme, according to the tone desired, of elutriated English red. The author asserts that acquaintances of his have used this paint even for priming trucks, supplementing it for greater durability with a coat of ordinary linseed oil varnish.

Protective Paint for Metal and Masonry.—Siderosthen is the name of a mixture of sulphurized mineral oil and a black, drying pigment (carbon) serving as a protective coating for metals and masonry. In order to attain a working consistency, this medium receives an addition of crude benzol which quickly evaporates after the application, leaving behind a tough, elastic coating. The latter is not attacked by the air, is impervious to smoke gases, sulphurous acid, hydrogen sulphide, sulphuric acid and hydrochloric acid, as well as to alkaline liquids; it even resists high temperatures very well. The coating, it is true, softens upon the first heating, but soon hardens again, and will subsequently remain intact as long as the article covered with it does not attain red heat.—Deutsche Mechaniker Zeitung.

Preservative Coating for Wood.—A durable coating for wood is obtained, according to the Deutsche Tischler Zeitung, by extracting petroleum asphalt, which can be had very cheaply, with light petroleum, benzine or gasoline. For this purpose the asphalt is coarsely powdered and digested for one to two days, with benzine in well-closed vessels, at a moderately warm spot. Petroleum asphalt is the residue, which results when the distillation of petroleum is for the production of many paraffine-like heavy oils, continued until, instead of the tar, a glossy, firm, pulverizable mass of conchoidal fracture and resembling colophony in consistency remains. The benzine dissolves from this asphalt only a yellowish-brown dyestuff, which deeply enters the wood and protects the same against the action of the weather, worms, dry rot, etc. The paint is not opaque, hence the wood retains its natural fiber. It is very pleasant to look at, because the wood treated with it keeps its natural appearance. The wood can be washed off with soap, and is especially suited for country and summer houses.

Waterproof Coating of Gluten and Glycerine.—The gluten obtained from wheat and other cereals is usually separated from the starch by the wet process, and in a fresh state is tough, viscous and scarcely soluble in water. In a moist state gluten quickly ferments, losing its toughness and adhesive qualities and becoming partly soluble in water, hence useless for a waterproof coating. Experience has shown that dried gluten absorbs water at ordinary air temperature, thus becoming viscid and plastic again. By drying at 93 deg. C. and above, gluten becomes hard and loses its capacity of absorbing water in so much greater a degree, the higher the drying temperature is and the longer it acts. It has been observed, says the Farben Zeitung, that when gluten dried at an ordinary temperature, hence capable of absorbing water, is mixed with glycerine and heated, the gluten becomes water-repelling and the mixture suitable as a waterproof paint. Accordingly, 1 part of gluten is mixed with 1½ parts of glycerine, whereby a slippery mass is obtained, which is applied on fabrics subsequently subjected to a heat of 120 deg. C. The heating should not last until all glycerine has evaporated, otherwise the coating becomes brittle and peels off.

Surfacer.—This is produced, says R. Stuebling in the Praktischer Wegweiser, from graphite, ocher, whiting, litharge and white vitriol. The ratio of the ingredients is as follows: Elutriated graphite, 2.25 kilogrammes; finely elutriated ocher, 2.25 kilogrammes; finely crushed whiting, 0.48 kilogramme; litharge, 0.06 kilogramme; finely crushed white vitriol, 0.06 kilogramme. The different ingredients are intimately mixed and sifted through a fine sieve. For the purpose of applying on wood, this mass is stirred together with two parts of turpentine and one part of varnish, so that the whole forms an intimate, thickly liquid substance. White lead is not required, whereby a great saving is made. Saturate the wood with oil before applying this rubbing composition. Apply with the brush or even with the spatula. Since the mass dries quickly, three to four coats may be given in 24 hours. After the last coat is dry, the rubbing down may be commenced, steel-wool or pumice stone and water, or possibly carborundum and water, being employed therefor, according to the class of work. In using the two last-named rubbing materials, use a piece of strong wool felt, or for the profiles a thinner piece or else a piece of cork. The respective profiles may be cut into the latter. This rubbing ground rubs readily and promptly affords a fine even surface and a firm foundation for varnish. It also gives, if worked up well and to the right consistency, a good putty for repairing defective places in the wood.

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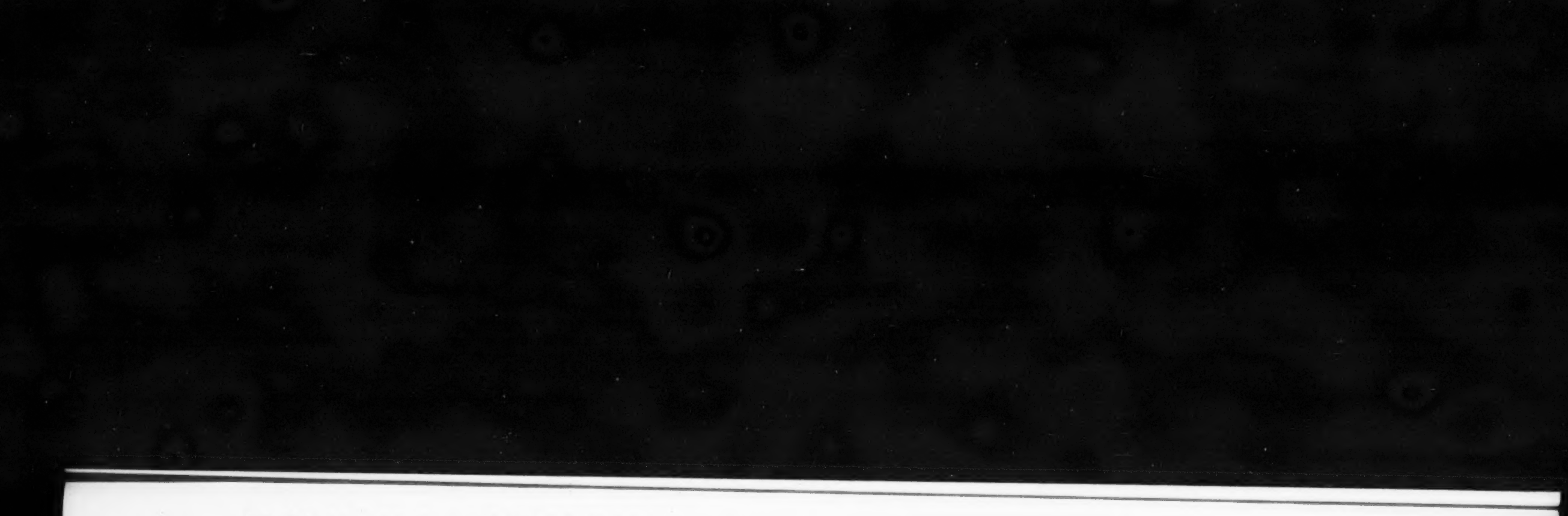

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